Investigating the Impact of Exchange Rate Volatility on Naira Exchange Rate in Nigeria

Adenekan, A. T., Sanni, G. K. and Itodo, A. I.*

Abstract

This study investigates the impact of naira-to-dollar exchange rate volatility on naira exchange rate returns in Nigeria. Using daily percentage exchange rate returns of the naira per US-Dollar, the study estimated an AR(5)-TGARCH (1,1) to examine whether there is an existence of asymmetry in the time path of the naira exchange rate volatility. The findings indicated that exchange rate volatility leads to increase in exchange rate returns (depreciation). Also, there is the presence of asymmetry in the movement of the exchange rate volatility, such that negative shocks that cause exchange rate returns to fall lead to fall in volatility by a size higher than the impact of positive shocks of the same magnitude. The paper recommends that the monetary authority should intensify its monitoring of the exchange rate behavior to curb excessive volatility or erratic market swings. It should also continue to ensure effective implementation of market rules and guidelines to checkmate any speculation-induced arbitrage opportunities and foster credible exchange rate management.

Keywords: Exchange Rate Volatility, Exchange Rate Returns, Speculative Bubbles, T-GARCH

JEL Classification Numbers: C22, F31

I. Introduction

Economists commonly agree that macroeconomic fundamentals, which manifest in the productivity and overall output level in an economy, are the ultimate determinants of the value of the country's currency, relative to other countries. These underlying economic factors, such as the level of international trade and tourism, inflation outlook, interest rates differentials, capital flows, have been detailed in the various theoretical models of exchange rate determination, and particularly summarized in the various classical concepts of Purchasing Power Parity (PPP), Fischer's Interest Rate, and Market Fundamentals theories, among others. Of a particular bearing is the international financial environment, whereby portfolio investments and the capital movements across countries and the associated exchange rate regimes become critical considerations in the behavior of exchange rate.

* *Adenekan, Adedapo T., Sanni, Ganiyu, K. and Itodo, Ahmed I., are staff of the Research Department, Central Bank of Nigeria. The usual disclaimer applies.*

The foreign exchange market is the largest traded market globally, and the huge volume of the transactions involved provides arbitrage opportunities for speculators, given that the currency values swing by the moments. Such speculation, driven by market expectations typically influence the behavior of the exchange rate and constitutes a distortion, fueling an environment of increased volatility in exchange rate. Volatility in exchange rates has far reaching implications for macro and financial stability. It can affect trade negatively, through its tendency to engender exchange rate misalignment. Relentless gyrations deter foreign direct investment, due to the high risk associated with exchange losses, since operating profit of multinational companies that face competition in the domestic environment of operations could be affected.

Volatility is also distortionary to market mechanism; hence, it distorts merchandise trade as well as capital flows. The distortionary effects of prolonged volatility also have implication on determining whether the currency is overvalued or undervalued. Pronounced volatility by itself can further fuel expectations of future realized volatility—that is, volatility clustering. Such behavior tends to intensify the speculative component that can create exchange rate bubbles. By the same token, however, it could bring about higher foreign portfolio investment as investors seek "hot money" arbitrage, with the attendant effect of capital flight when developments are not favorable. This calls for hedging, which by implication represents additional cost to the investors.

Furthermore, an implication of exchange rate bubbles is irrational exuberance, whereby the movement in exchange rate is no longer driven by the economic fundamentals, but by strong psychological pressures driven by the belief that the rates will keep depreciating or appreciating, depending on how it all started—a kind of self-fulfilling prophesy. This situation can be described as "the currency wagging the tail of economic dog." Buiter and Pesenti (1990) noted that instantaneous volatility of exchange rates within a band is not necessarily less than the volatility under free float. Severe fluctuations can also be taken to be an indication of exchange rate overshooting, a situation whereby short-run response to the change in market fundamentals is greater than its long-run response, with the propensity to further propel the volatility in the rate.

The exchange rate policy in Nigeria aims to preserve the value of the domestic currency, maintain a favorable external reserves position and ensure external balance without compromising the need for internal balance and the overall goal of macroeconomic stability. In the country, exchange rate behavior has been more volatile in the recent years, and it might be safe to assume that much of these swings are largely driven by some psychological pseudo-fundamental dynamics which are not related to economic fundamentals. In addition to the associated uncertainties and adverse impact on the growth of exports and overall output, volatility in the value of the nation's currency could render monetary aggregates less credible as a key indicator in the monetary authority's toolkit.

To the extent that maintaining a realistic exchange rate for the naira is very crucial, an understanding of its behavior, outside of the conventional structural determination, is of utmost importance. This study is therefore apt and very relevant given that one of the major challenges of the Central Bank of Nigeria is the management of exchange rate and the smoothening of the swings associated with exchange rate movements. Over the years, the Central Bank of Nigeria has adopted several exchange rate regimes – controlled, float and managed float, with intermittent interventions measures to achieve stability in the market, albeit at an enormous cost.

The objective of this study is to empirically determine the impact of volatility on the time path of the naira, by empirically estimating the exchange rate volatility series and regressing these series on the exchange rate returns (depreciation or appreciation). This will inform whether the fluctuation in the exchange rate of the naira reflects or propels further, its volatility, and whether such volatility is a potent information in determining the market value of naira. This study also endeavors to analyze the asymmetric effect of shocks to the exchange rate process on the volatility of the exchange rate. An important assumption in this study is that all economic fundamentals driving the exchange rate are already reflected in the market value of naira, which allows us to capture the volatility or speculative components as the main driver of exchange rate during the period under study.

It is important to note that studies on the exchange rate, as it relates to its volatility behavior in Nigeria are few and have mostly used relatively low frequency data (for example, Adeoye and Saibu, 2006; Olowe, 2009; Adeoye and Atanda, 2011; and Bala and Asemota, 2013). This study therefore departs from other studies by using daily series volatility—higher frequency data—unlike the weekly or monthly series used in other studies. The advantage from this is the tendency to more adequately capture the transitory speculative features inherent in the series. Furthermore, unlike other studies, we use the Granger Non-Causality to test between exchange rate returns and its conditional variance (volatility), to provide a formal validation of the impact of volatility factors on the conditional mean.

The rest of this paper is structured as follows: Following this introduction, section 2 presents the theoretical and empirical review of the subject matter. In section 3, an overview of the data and summary statistics is provided. Section 4 provides the model specification, estimations and findings, while section 5 concludes, with policy implication and recommendations.

II. Literature Review

II.1 Theoretical Review

Several theories had been propounded to explain exchange rate determination and its behavior. The oldest and most simplistic classical theory was the purchasing-power-parity (PPP) developed in the 16th century writings of scholars from the University of Salamanca in Spain. Its model definition was however credited to Gustav Cassel (1921). The PPP is based on the law of one price, which states that if there are no transaction costs nor trade barriers for a particular good, then the price of that good should be the same at every location. Thus, the theory predicted that an appreciation in a country's exchange rate will approximate an amount equal to the excess of foreign inflation over domestic inflation. This is predicated on the idea that countries with relatively high rates of inflation will show currency depreciation, while countries with relatively low rates of inflation will experience currency appreciation. In equilibrium, the amount of depreciation (or appreciation) will reflect the inflation differential.

The PPP theory was criticized for not considering the impact of international capital movements, and suffers from the choice of an appropriate price index used in price calculations. Building on it, however, the International Fisher Effect (IFE) theory contended that what matters is not inflation rates differential, but the interest rate differentials. According to Fisher, exchange rate changes are directly proportional to the relative differences in long-term interest rates, because the long-term interest rates capture the market's expectation for inflation. Countries with relatively high long term interest rates (thus high inflation) will show currency depreciation, and vice versa. Hence, in equilibrium, the amount of depreciation (or appreciation) will be equal to the long-term interest rate differential (Fisher, 1930).

Other theories of exchange rate explain the behavior of exchange rate via the financial-asset markets perspectives, following two approaches, namely: the monetary-approach and portfolio-balance models approach. The monetary-approach assumed perfect substitutability of assets internationally, and argued that exchange rates are determined by changes in the supplies and demands of national currencies. To this school of thought, an increase in the domestic money supply causes the home currency's exchange rate to depreciate, and vice versa (see Frankel, 1976; and Dornbusch, 1976, for example).

Monetary approach also upheld that an increase in the domestic demand for money leads to an appreciation in the home country's exchange rate. The portfolio balance model of exchange rate, on the other hand, assumed imperfect substitutability of assets, and added the relative asset supplied as a determinant. The theory contended that stock and other financial assets adjustments are the drivers of exchange-rate movements. Thus, portfolio balance approach is broader than the monetary approach that only emphasised on national currencies. To the extent that central banks sterilisation occurs when domestic credit is changed to offset international reserve flows, and since balance-of-trade flows are balanced by financial-asset flows, changes in the trade balance have a role in asset-approach views of exchange rate determination (McKinnon and Oates, 1996; McKinnon, 1969; Girton and Handerson, 1973; among others).

Fundamentals and market expectations theory argued that, in the short run, exchange rates respond to real interest rate differentials or news about market fundamentals, and speculative opinion about future exchange rates. However, in the long-run, exchange rates are best explained by fundamental factors, such as real income differentials, inflation rate differentials and productivity changes, noting that international investors are especially concerned about the real interest rate (Froot, 1986); Meese and Rose, 1990; McDonald and Taylor, 1992; among others).

The modern Technical Analysis Model, originally designed in the context of stock market, has also been employed to understand market behavior of all assets, including foreign currency trading. To the Technical Analyst, foreign exchange market is particularly prone to trending, hence charts and price patterns can be used to forecast future movement in spot exchange rates. This is premised on the idea that the future path is nothing but a geometric representation of the past. In this sense, the financial information or news has minimal, if any, relevance. They therefore, assumed that historical relationship will result in similar moves in the future. The technical modeling innovation consists in the application of the theory of regulated Brownian motion, to the study of the behavior of a floating exchange rate that is constrained by appropriate interventions, not to stray outside some given range or target zone (Buiter and Pesenti, 1990).

The idea that the sporadic fluctuation in an economic variable can fuel further rapid movements in that variable has been well enunciated and investigated in the literature. Such proposition, regarding inflation, had been championed by Okun (1971) and popularised by Friedman (1976). Other scholars such as Hasbrouck (1979), Cukierman and Meltzer (1986), Ball Mankiw and Romer (1988), and Ball (1992), as well as, Adenekan (2012) for Nigeria, among others, had also developed formal models to investigate the relationship between inflation uncertainties and inflation behavior.

II.2 Empirical Review

Mussa (1986) opined that movements in relative goods prices between most countries are typically smooth, and that short-run variability in the real exchange rate mainly reflects the movement in the nominal rate. Buitler and Passenti (1990) considered a setup in which the existence of speculative behavior is a factor that the Central Bank has to deal with. They showed that the defense of the target zone in the presence of bubbles is viable if the Central Bank accommodates speculative attacks when the latter are consistent with the survival of the target zone itself and expectations are self-fulfilling. Their result hold for a large class of exogenous and fundamental-dependent bubble processes. Their findings indicated that the instantaneous volatility of exchange rates within a band is not necessarily less than the volatility under free float. The characteristics of exchange rate and the impact of its volatility have also been documented in many empirical studies, such as McKenzie (2002) and Stavarek (2007 and 2010), that investigated the asymmetric effects of exchange rate volatility in some European countries. They all found the presence of asymmetry in the volatility of the currencies in the countries considered.

Neely and Weller (2011) investigated the application of technical analysis modeling in the foreign exchange market. In their survey, the findings showed that the technical model dominated fundamental analysis at the short horizons. These findings were first established for traders in the London market but have subsequently been confirmed to hold in other markets. According to them, Technical Trading Rules (TTRs) were able to generate excess returns over a long period during the 1970s and 1980s. This, however, disappeared by the early 1990s when exchange rate returns to more complex or sophisticated rules persisted. Furthermore, both out-of-sample analysis and adjustments to statistical tests indicated that the returns were genuine. With respect to the intervention operations of the central bank, the study also established that, if the central bank has a target for the exchange rate that differs from its fundamental value, intervention may allow speculators to profit at the expense of the bank. However, the use of high-frequency data showed that the periods of greatest profitability precede central bank interventions. Thus, intervention was correlated with periods of high profitability for technical rules.

Hu and Oxley (2017) employed the Generalized Sup ADF (GSADF) unit root tests of Phillips et al. (2015) to investigate the evidence for exchange rate bubbles in some G10, Asian and BRICS countries from Mar.1991-Dec.2014. Specifically, they tested for the explosiveness and its causes in the nominal exchange rate, and whether such explosiveness is driven by rational bubbles or exchange rate fundamentals. Results for some G10 cross rates suggested no evidence of bubbles in most exchange rate pairs with only a few exceptions. For the Asian currencies, the relative prices of traded goods play an important role in explaining majority of the movements in the US Dollar-Philippine Peso, US Dollar-Indonesian Rupiah and US Dollar-Singapore exchange rates, confirming the presence of rational bubbles, especially during the 1997 Asian Financial Crisis. Results from the three BRICS countries (Brazil, India and South African) suggest that the relative prices of traded goods account for majority of the movements in exchange rates, which indicated evidence of bubbles and explosive behavior for these currencies. Moreover, there was also evidence of significant explosive behavior in the US Dollar-Mexican Peso exchange rate as well, supporting the hypothesis of a bubble in the US Dollar-Mexican Peso exchange rate during the 1994/95 Mexican currency crisis. Finally, the paper noted that newly emerging countries, with relatively shallow financial markets, may be more likely to exhibit bubbly behavior in foreign exchange markets than more mature G10 countries.

Vadivel and Sampath (2017) examined whether the huge variation observed in exchange rate and foreign currency assets (FCA) in India contain any long memory property in the foreign exchange markets. The paper employed monthly data for the period, January 1993 to March 2017, and adopted the fractionally integrated autoregressive moving average (ARFIMA) framework by Granger and Joyeux (1980) and Hosking (1981). Their findings indicated an existence of long memory property in the foreign exchange rate, and thus recommended the fixing of the reference rate and frequent intervention in the foreign exchange market to minimise variation of exchange rate in a bid to promote export.

For South Afrcia, Itodo, Usman and Abu (2017) investigated the behavior of the volatility in the South African Rand/USD exchange rate between 2001 and 2017, within the context of EGARCH-M (1, 1) model. The specific objectives of their study were to assess the impact of exchange rate volatility on its market value, and determine if there was the presence of asymmetric effect in the times path of the volatility from shocks to its market value. They found that the value of the Rand responded negatively to volatility, indicating the appreciation in Rand under "conditions of less tranquility." They also found an evidence of asymmetric effect of shocks to the conditional mean, in the conditional variance of the Rand. Volatility in the RAND was more responsive (in this case, rising) to appreciation in the value of the RAND than when the Rand depreciates in value.

In Nigeria, a number of studies have examined the exchange rate behavior. For instance, Olowe (2009) employed the monthly Naira/Dollar exchange rate volatility within the context of the GARCH models. He found volatility to be persistent. However, the asymmetry models rejected an existence of leverage effect, notwithstanding the statistical significance of all the coefficients of the variance equations. The asymmetric models TS GARCH and APARCH were also found to be the best models. Bala and Asemota (2013) used monthly data series from 1985:1 to 2011:7 to investigate naira exchange rate volatility within the framework of GARCH. Their findings revealed the presence of volatility in naira exchange rate of US dollar, euro and British pound. The study further found that most of the asymmetric models rejected the existence of a leverage effect except models with volatility break. The paper recommended that when designing exchange rate policies, the authority should incorporate key and significant domestic and international events that are likely to affect the fluctuation of the naira.

Omotosho (2015) also estimated the probabilities of currency crisis as a logistic function of selected macroeconomic indicators, in constructing an early warning system for currency crises in Nigeria. The study, in particular, investigated the extent to which the real exchange rate misalignment could be used as a leading indicator of currency crisis, by disentangling the impacts of exchange rate volatility and real exchange rate misalignment on the probability of currency crisis. Among others, the study revealed that real exchange rate misalignment increases the probability of crisis. The real exchange rate volatility, in particular, was very robust and improves the performance of the model.

David, Dikko and Gulumbe (2016) examined the naira exchange rate vis-a-vis US dollar, euro, British pound and Japanese yen, using the GARCH (1,1), with the objective of investigating the characteristics of exchange rate volatility in

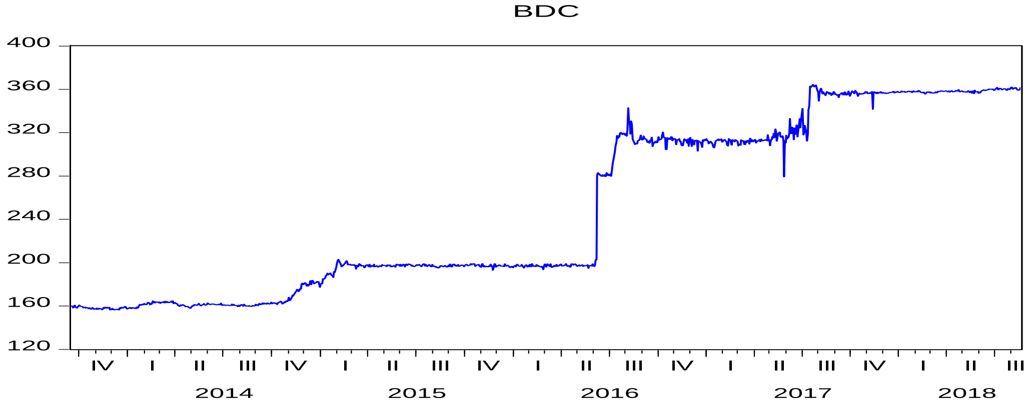
Nigeria and model it with exogenous variables to measure any improvement or otherwise of the specified models, as well as, to determine the forecasting performance of the specified models. Unlike Bala and Asemota (2013) who used monthly series, David et al used weekly series, which is relatively higher in frequency, in addition to other exogenous variables—On Net Returns, Irregular Trading Days and Policy Change Dates—in both the mean and variance equations. These studies found a volatility persistence of various forms, which are also consistent with Adeoye and Atanda (2011) and Oshinloye and Olufemi (2015), among others. Our study departs from others, by specifically using the estimated volatility series extracted to assess their impacts on the exchange rate return series (that is, the depreciation or appreciation). Furthermore, unlike other studies, we use higher frequency daily data series that could capture the intensity of swings in the data.

III. Data Description and Summary Statistics

The data used were the daily exchange rate (5-day/week) of *naira* versus the United States' *dollar* (N/$), that is, *naira*/US$, obtained from the Central Bank of Nigeria database. The data covers the period, September 6, 2013 to September 12, 2018. The data were transformed into logarithmic form before estimation, such that the exchange rates were in the returns series form. This is consistent with the theoretical arguments for the preference of logarithmic returns [Strong (1992) and Christoffersen (2012)].

Figure 1 illustrates the behavioral movement of the exchange rates of the naira relative to the United States dollars (*naira*/US$). As depicted in the Figure, the movement in the naira exchange rates exhibits persistent depreciation amid intermittent appreciation, reflecting some degree of volatility in the series over the years under study. For example, between September 2013 and September 2014, daily exchange rate at the Bureau-de-Change (BDC), hovered around ₦158 to ₦162.70 per US dollar on average. Afterward, it depreciated further until it revolved around ₦192 per US dollar in February 2015, following which the depreciation continued with steady fluctuations, hovering between ₦195 and ₦199 per US dollar through July 2016. Following the technical devaluation policy implemented in June 2016, naira exchange rate rose and experience a sharp depreciation to ₦280 per US dollar, with the variability in the exchange rate becoming more pronounced—a possible volatility clustering. On August 9, 2017, the value of exchange rate hit the global peak, at ₦364 per dollar. Since then, and through the rest of the study period, exchange rate has hovered around ₦360 per dollar.

Figure 1: The Exchange Rates of the Naira Relative to the United States dollars (*naira*/US$1)



For the entire period under investigation, the summary statistics indicated that the arithmetic mean value of the exchange rate was ₦249 per US dollar. The higher mean value was largely attributed to the post June 2016 technical devaluation and the attendant rise in the naira exchange rate henceforth, as the median and mode values were approximately ₦199 per dollar. Notice also that the range was higher than the median and mode, at ₦208.01 per dollar—a reflection of the sharp depreciation following the policy shift. The high value of Jarque-Bera statistic is also an indication that the distribution from which the data come from may not be non-normal, which may be attributed to some outliers and jumps in the series.

Table 1: Summary Statistics of the BDC rates, September 6, 2013 to September 12, 2018

Mean	249.5199
Median	198.25
Mode	199
Standard Deviation	79.52119
Sample Variance	6323.62
Kurtosis	1.3126
Skewness	0.250412
Range	208.0084
Minimum	156.41
Maximum	364.4184
Jarque-Bera	166.0961 *(Prob. = 0.0000)*
Observations	1287

Source: Author's Estimates

IV. Model Specification, Estimation and Findings

In line with the objectives of this study, we use a modified version of the traditional Threshold GARCH (T-GARCH) model. Here, the conditional mean equation (1) is an AR (5) process, with a constant and a lagged conditional variance. Hence, the model specified is an AR (5), TGARCH (1, 1) in mean model. This allows us to evaluate the impact of a predetermined volatility on the contemporaneous values of the exchange rate returns. Secondly, an asymmetric term is introduced in the conditional variance equation (2), to account for possible asymmetries in the conditional variance.

$$DEXR_t = a_0 + a_1 DEXR_{t-1} + a_2 DEXR_{t-2} + a_3 DEXR_{t-3} + a_4 DEXR_{t-4}$$

$$+ a_5\, DEXR_{t-5} + \psi\sigma_{t-1}^2 + u_t \quad (1)$$

$$\sigma_t^2 = \alpha_0 + \alpha_1 u_{t-1}^2 + \beta_1\sigma_{t-1}^2 + \gamma(u_{t-1}^2 * D_{t-1}) + v_t \quad (2)$$

Where, in the conditional mean equation, $DEXR_t$ is the percentage exchange rate returns of the naira, defined as the logged first difference of the Naira exchange rate; $DEXR_{t-1\,to\,t-5}$ and σ_{t-1}^2 are the AR and GARCH terms in the conditional mean equation, respectively; the coefficients α_i (for I = 0, 1, . . . , 5) and ψ are parameters to be estimated in the conditional mean equation; u_t is the error term, which is assumed to be a white noise process.

In the conditional variance equation, $u_{t-1}^2$is the lagged square of the residual of the conditional mean equation; $\sigma_{t-1}^2$is the lagged GARCH term in the conditional variance equation; $(u_{t-1}^2 * D_{t-1})$ is the dummy component, also called asymmetric term; α_0, α_1, β_1, and γ are the associated parameters to be estimated in the conditional variance equation, respectively; v_t is the error term.

The asymmetric or threshold term tells how an impact from the positive shock varies from that of negative shock. It has been specified to determine whether negative shocks have more impact than the positive shocks; that is, whether exchange rate is more volatile when it is rising (a depreciation) than when it is falling (an appreciation). To account for this, γ is expected to be significant. For non-negativity of the conditional variance, all coefficients are expected to be positive. But if γ is negative, $\gamma + \alpha_1$ must be positive. [1]

[1] The condition of non-negativity of the conditional variance is necessary because negative volatility does not make sense.

IV.1 Unit Root Tests

Estimating the conditional mean equation specified above, like other time series models, requires $DEXR$ to be stationary. This is necessary to avoid estimating a spurious regression, as the ARCH series in the conditional variance equation is a direct derivative of the conditional mean. As a precondition, therefore, it is important to invariably verify the unit root property of $DEXR$ to avoid misspecification of the conditional mean. Thus, we conducted the unit root tests to determine the stationarity conditions for the series, following the ADF, PP and KPSS techniques. The results from the unit root tests, as illustrated on Table 2, show that exchange rate returns are stationary in each case, that is, With Constant, With Constant and Trend, and Without Constant and Trend. The null hypothesis of "unit root" in the series is strongly rejected at 1 percent in both the ADF and PP tests, while the null hypothesis of "no unit root" cannot be rejected in the KPSS test.

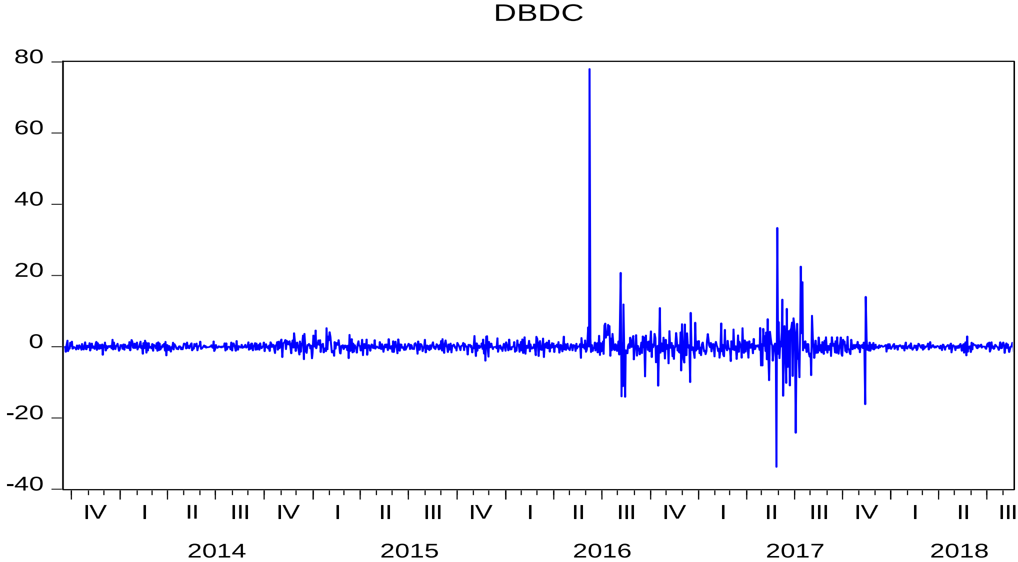
Table 2: Unit Root Tests on DBDC

	ADF t-statistic *(Prob. In parenthesis)*	PP t-statistic *(Prob. in parenthesis)*	KPSS t-statistic *(Prob. In parenthesis)*
With Constant	-10.2058 *(0.0000)****	-42.9144 *(0.0001)****	0.1065 *(No)*
With Constant & Trend	-10.2081 *(0.0000)****	-42.9059 *(0.0000)****	0.0893 *(No)*
Without Constant & Trend	-9.9941 *(0.0000)****	-42.5494 *(0.001****	====
*Notes: (***) Significant at the 1%; (no)= Not Significant; *MacKinnon (1996) one-sided p-values.*			

Source: Author's Estimates

Figure 2 is the percentage exchange rate returns of the naira. This series appears to be stationary around a zero mean, and exhibiting higher degrees of volatility between the periods 2016 to mid-2017. In addition, it appears to show some level of volatility clustering over the same period.

Figure 2: The Percentage Exchange Rates Returns of the Naira



Source: Author's Estimates

IV.2 T-GARCH Conditional Mean and Variance Equation

The results of the estimated conditional mean equation (1) and variance equation (2), as specified in equations (1) and (2), are presented in Table 3. The lag length chosen was five. The assumption was predicated on the idea that the series follows 5-day spot price. The upper component on the table is the results for the conditional mean equation (1), while the lower part is the results for the conditional variance. The coefficients of all the autoregressive (AR) terms in the mean equation are negative, strong and statistically significant at 1 percent. This indicates that the previous values generally lead to a fall in future exchange rate returns.

Also, the coefficient of the GARCH term in the mean equation is positive and statistically significant at 1 per cent level. This means that an increased volatility leads to an increased decline in exchange rate returns (i.e., the depreciation). The implication is that exchange rate depreciates more with volatility, than without it. The coefficient of the asymmetric, or threshold term, in the variance equation is negative and statistically significant, suggesting that negative shocks has more impact on volatility than the positive shocks with the same magnitude. The implication is that, negative shock, which causes exchange rate returns to fall, leads to a reduction in volatility by a size higher than the impact of positive shocks of the same magnitude, thus, causing exchange rate returns to rise. The negative sign implies that exchange rate returns exhibits less volatility when it falls (appreciates) than when it rises (depreciates).

Table 3: Results of Estimated Conditional Mean and Variance Equations

Dependent Variable: DBDC				
	Coefficient	Std. Error	z-Statistic	Prob.
GARCH	0.005655	0.002302	2.456861	0.0140
DBDC(-1)	-0.645556	0.027687	-23.31599	0.0000
DBDC(-2)	-0.358047	0.035543	-10.07370	0.0000
DBDC(-3)	-0.207380	0.020565	-10.08425	0.0000
DBDC(-4)	-0.187022	0.018431	-10.14723	0.0000
DBDC(-5)	-0.047905	0.016292	-2.940476	0.0033
Variance Equation				
C	0.131324	0.019379	6.776506	0.0000
RESID(-1)^2	1.771536	0.086194	20.55278	0.0000
RESID(-1)^2*(RESID(-1)<0)	-0.714951	0.097611	-7.324495	0.0000
GARCH(-1)	0.408023	0.011578	35.24212	0.0000
R-squared	-0.002072	Mean dependent var		0.155755
Adjusted R-squared	-0.006001	S.D. dependent var		3.536130
S.E. of regression	3.546725	Akaike info criterion		3.897539
Sum squared resid	16038.55	Schwarz criterion		3.937784
Log likelihood	-2486.374	Hannan-Quinn Criterion.		3.912650
Durbin-Watson Stat	1.717728			

Source: Author's Estimates

IV.3 Granger Non-Causality Test

To validate the impact of volatility factors on the conditional mean of the exchange rate returns, the Granger Non-Causality test was conducted to formally validate the long run relationship between exchange rate returns and its conditional variance (volatility). This was done within the framework of a vector autoregressive (VAR) model. The choice of lag length for the estimation was 8, as suggested by the Schwartz Information Criteria (SIC). The estimated VAR model was stable, as all its characteristic roots lay within the unit circle. (See Appendix Table 1a). The estimated conditional variance from our model is used as the proxy for the exchange rate volatility.

As indicated in Table 4 below, the null hypothesis that the conditional variance does not Granger-cause exchange rate returns is rejected at 5 per cent significant level. Similarly, the hypothesis that exchange rate does not Granger-cause the conditional variance is strongly rejected at 1 percent level of significance. Thus, there is a bi-directional causality, suggesting that predetermined values of each variable can be used to forecast the other. This therefore, validates the long-run relationship between exchange rate returns and its volatility.

Table 4: VAR Granger Causality/Block Exogeneity Wald Tests

Dependent variable: DBDC			
Excluded	Chi-sq	df	Prob.
COND_VAR	18.74326	8	0.0163
All	18.74326	8	0.0163
Dependent variable: COND_VAR			
Excluded	Chi-sq	df	Prob.
DBDC	911.1090	8	0.0000
All	911.1090	8	0.0000

Source: Author's Estimates

V. Conclusion and Policy Recommendation

Understanding exchange rate behavior, with particular focus on the degree and magnitude of its volatility is important for Nigeria, given its structural dependence on the external sector. An increased volatility in the exchange rate of the naira would create much concerns over the speculative attack and its attendant bubble in the foreign exchange market. The implication is the adverse impact on the growth of exports, output, and its potency at undermining the effectiveness of monetary policy management, in view of the pass-through effects of exchange rate to domestic prices. To this extent, the policy objectives, which are directed at exchange rate stability, would benefit immensely from empirical research directed at investigating the true behaviour of the exchange rate volatility and its implication on the value of the naira. It was against this backdrop that this study, sought to investigate the impact of exchange rate volatility on naira exchange rate in Nigeria.

Using daily percentage exchange rate returns of the naira, the study estimated an AR(5)-TGARCH (1,1) in mean model to study the impact of exchange volatility on exchange rate returns, and to determine the existence of asymmetry in the time path of the naira exchange rate volatility. The results showed a high and persistent volatility in the naira-to-dollar exchange rate, despite frequent interventions to defend the value of naira by the monetary authority. It also found that exchange rate volatility leads to increase in exchange rate returns (depreciation) and vice versa. In addition, the study found the presence of asymmetry in the movement of the exchange rate volatility. This asymmetry is such that negative shocks, which cause exchange rate returns to fall, lead to fall in volatility by a size higher than the impact of positive shocks of the same magnitude, which cause exchange rate returns to rise.

As part of the policy recommendation from this study, while the monetary authority's commitment to defend naira is recognized, this paper urges a close monitoring of the volatility of naira exchange rates, in a bid to curb, ex-ante, excessive volatilities or erratic market swings. This would position the authority, ready to bear or intensify its intervention in the foreign exchange market toward engendering stability. Intensifying the monetary authority's on-going cocktail of policy strategies consistently, as long as it is sustainable, would go a long way to dampen volatility or erratic market swings. The authority is therefore urged to not discontinue or abandon its plan, while continually monitoring the band within which the gyration could be controlled, with an intensity of intervention as may be necessary.

Since volatility can be ignited and perpetuated by speculative bubbles, which by itself is an intrinsic factor in the market, with the tendency to further fuel exchange rate volatility, it is incumbent on the authority to reduce the downside risk, and ensure its commitment toward an effective implementation of market rules and guidelines. This would help to checkmate speculator induced arbitrage opportunities. It is critical to reduce or eliminate the breeding ground or activities that could create a self-fulfilling market behavior toward induced arbitrage that is a common phenomenon in the foreign exchange market.

Furthermore, exchange rate management should be credible. When bounds are set, market actors and stakeholders, in general, should have the confidence that intervention rules to defend the naira are transparent, consistent and credible.

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APPENDIX

Figure 1a: Graphical Plot of BDC and Returns on BDC (DBDC)

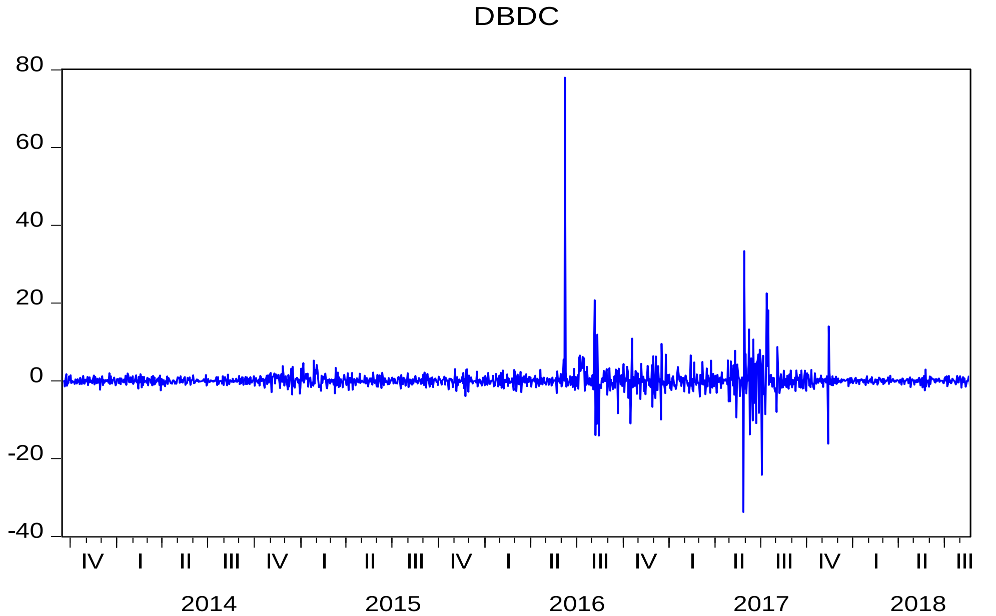
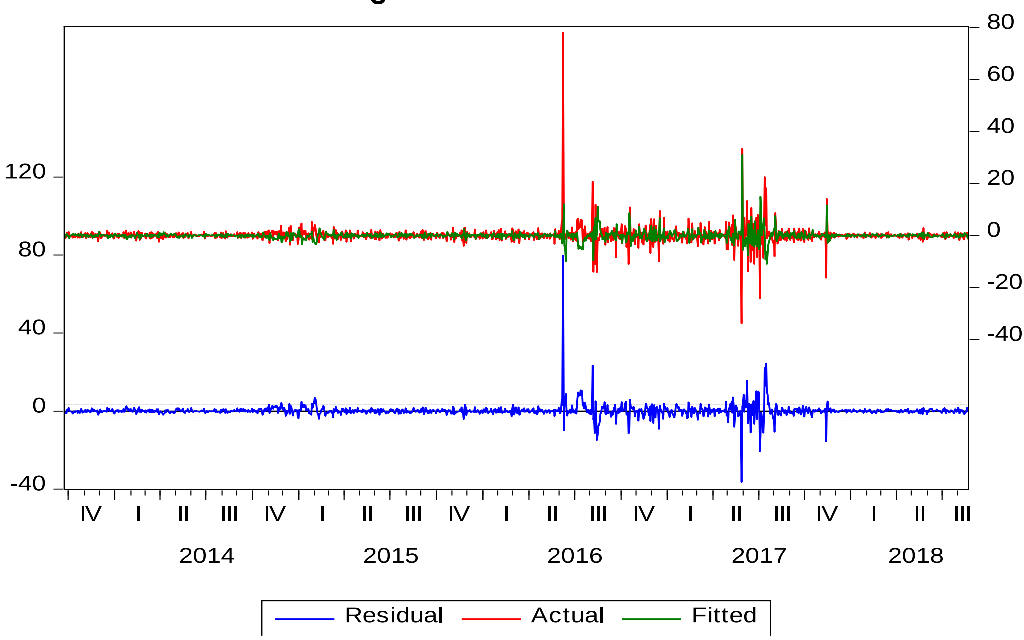
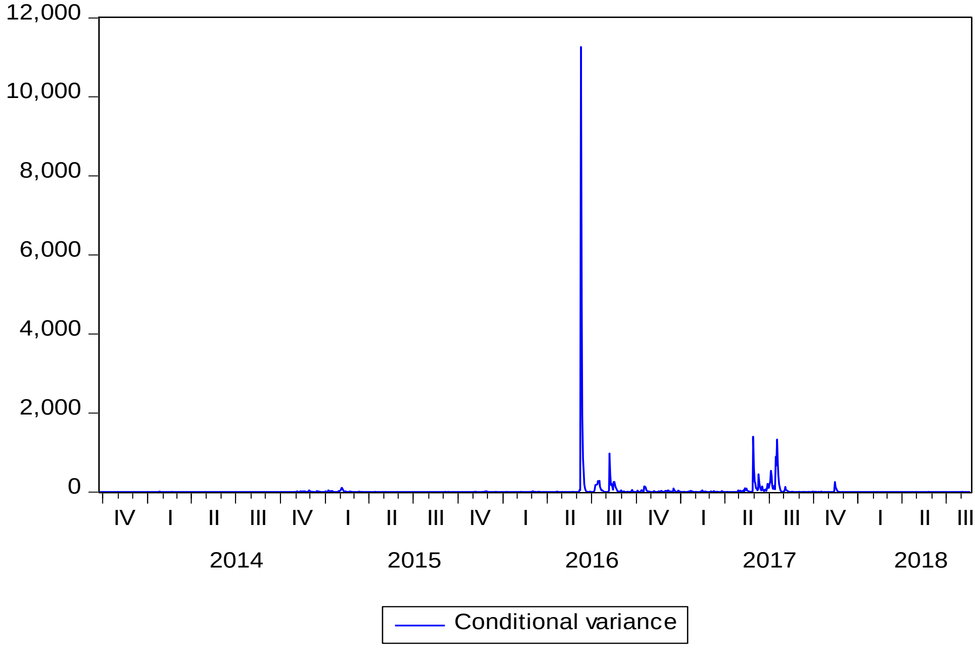


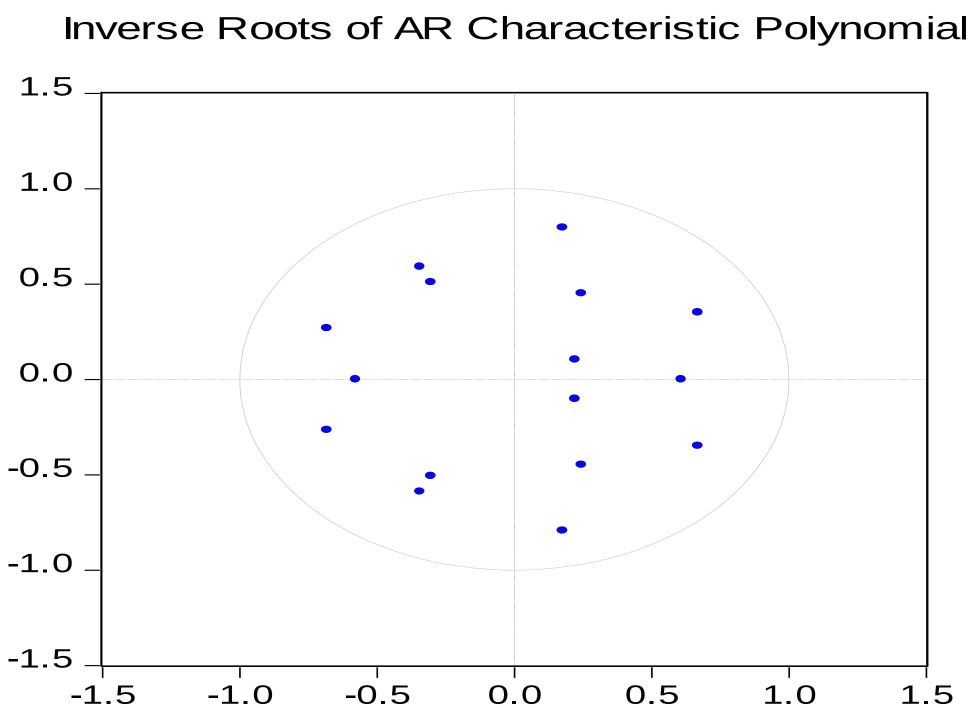
Figure 1b: Fit of the Model

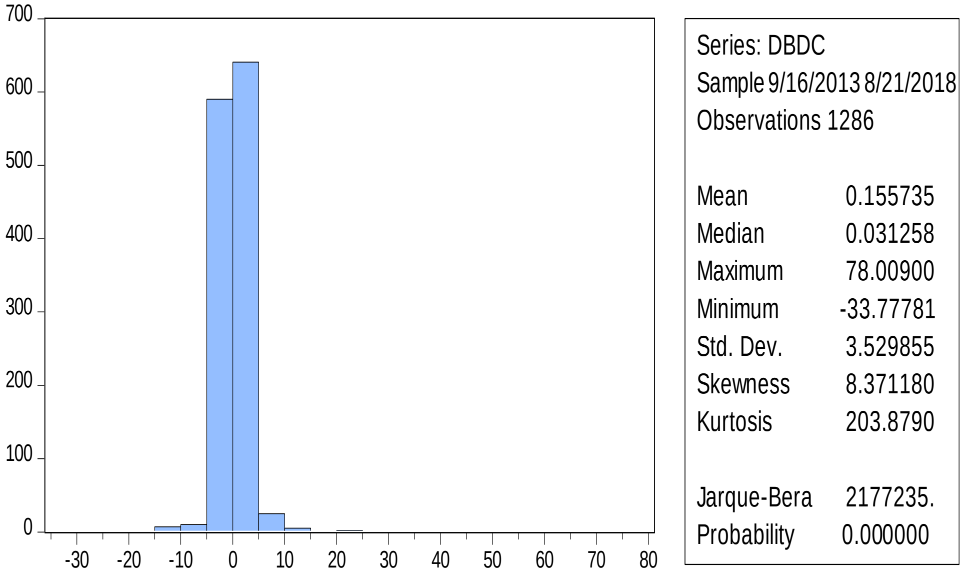


Appendix Figure 1c: Conditional Variance Plot from the Estimated Model



Appendix Figure 2a: Inverse Root of AR Characteristic Polynomial




Series: DBDC
Sample 9/16/2013 8/21/2018
Observations 1286
Mean 0.155735
Median 0.031258
Maximum 78.00900
Minimum -33.77781
Std. Dev. 3.529855
Skewness 8.371180
Kurtosis 203.8790
Jarque-Bera 2177235.
Probability 0.000000
700
600
500
400
300
200
100
0
-30
-20
-10
0
10
20
30
40
50
60
70
80