ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 8| Issue: 8| August 2022|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

# MACROECONOMIC DETERMINANTS OF EXCHANGE RATE VOLATILITY IN NIGERIA: AN EMPIRICAL ANALYSIS (1981-2019)

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**ABSTRACT**

***The purpose of this research work is to empirically investigate the determinants of exchange rate volatility in Nigeria. Using quarterly time series data from 1981 to 2019.Augumented Dickey- fuller(ADF) stationarity test was used, ARCH and GARCH(1.1) model, long-run and short-run relationship between variables has been investigated using johansen cointegration and Vector Error Correction(VECM) .The model confirmed the existence of short-run and long-run relationship between exchange rate volatility and macro-economic variables such as Reserve,Inflation,GDP,MCAP,and Trade balance,.The Error Correction term is statistically significant in each of the cointegrating equations and is negative the result revealed that change in money supply is positively related to changes in exchange rate volatility equally revealed a short-run effect between exchange rate volatility with Reserve,govt expenditure,MCAP, and trade balance to be positive, and positive short-run relationship between money supply and inflation. The GARCH (1.1) results show that macro-economic variables such as GDP,INFL and MCAP had negative values and significant impact on mean value of exchange rate volatility except trade balance which is statistically in significant ,this shows that at least six of the seven variables have significant impact on exchange rate volatility. This research work therefore, recommends for structural reforms, diversification of the economy, exchange rate policy reforms among other things.***

**KEYWORDS:** ***Exchange Rate Volatility, Exchange Rate Regimes, Money supply, Trade Balance, GARCH.ECM***

## INTRODUCTION

The exchange rate and its volatility are important variables influencing Nigerian economic activity. As a result, variations in the foreign currency (FX) market have long piqued the interest of economists and statisticians alike. When the FX market is examined by volume, it is discovered that worldwide daily FX transactions topped $4 trillion in 2010, which is more than the yearly value of global commerce (Bank for International Settlement, 2010). The world's total foreign reserves increased to $9.7 trillion in 2010, whereas Nigeria's reserves peaked at $64 billion before the global financial crisis in 2008 and fell to $31.7 billion in late–2011 (BIS, 2010; CBN, 2011). Exchange–rate volatility refers to swings or fluctuations in the exchange rate over time. Since the establishment of flexible exchange–rate regimes in 1986, the Naira has been very volatile versus major currency rates in Nigeria. As a result, continuous exchange rate volatility was assumed to have resulted in currency crises, production pattern distortions, and abrupt swings in external reserves. Currency discussions have recently taken center stage as a result of the Eurozone currency and sovereign debt crises, US dollar volatility, worries about China's currency rates, and the strengthening of the Japanese yen, among other factors.

Greene (2014) observes that uncertainty associated with exchange rates is an unobservable variable of economic importance, and several extensions have been proposed since the development of autoregressive conditional heteroscedasticity (ARCH) models in the 1980s, including: GARCH, EGARCH, TARCH, TGARCH, DTARCH, VGARCH, APARCH, STARCH, and STAR, among others. While traditional econometric models are estimated under the assumption of variance homogeneity, GARCH models enable the conditional variance to fluctuate over time as a result of previous mistakes while keeping the unconditional variance constant (see the seminal papers of Engle, 1982). Nigeria has used many exchange–rate systems since transitioning from a fixed to a flexible exchange–rate system.

From 1986 to 2012, the following frameworks were used in the FX market: the dual exchange–rate system (1986–1987), the Dutch auction system (DAS) (1987), the unified exchange–rate system (1987–1992), and the fixed exchange–rate system (1992–1998). The reintroduced DAS (1999–2002), the retail Dutch auction system (2002–2006), and the wholesale Dutch auction system (2006–to date) are others. As a result, modelling efforts must include exchange rate regimes in connection to specific macroeconomic factors that have had an impact on Nigerian economic development through exchange rate since 1986. This has already inspired a

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number of previous publications; so, the purpose of this research is to investigate the effect of macroeconomic factors on exchange rate volatility in Nigeria using the conventional GARCH model and VECM.

## 2.0 LITERATURE REVIEW

Review of related literature examined few studies on macro-economic factors that determined foreign exchange rates movement.

Mpofu (2020) examined the determinants of real exchange rate volatility in South Africa using quarterly time series data from 1986 to 2015. The study used ARDL cointegration approach and found that real exchange rate volatility is higher in flexible exchange rate regime and that an increase in the volatility of gold price generates more volatility of real exchange rate while an increase in the volatility of output, money supply and government consumption is associated with a reduction in real exchange rate volatility.

Ojo and Temitayo (2018) examined the determinants of exchange rate in Nigeria using the ARDL Bounds test approach to co-integration from 1986 to 2016. The study found that the gross domestic product, Interest rate and inflation rate have positive effect on exchange rate in Nigeria while degree of openness recorded a negative effect on exchange rate in Nigeria. This study examined the determinants of exchange rate without necessary assessing how they affect volatility clustering in exchange rate in Nigeria. Ramli (2020) also examined the determinants of exchange-rate volatility from 2004 to 2015. The study used GARCH (1, 1) and found that that trade openness, reserve assets, and stock market index negatively and significantly determine the exchange-rate volatility while productivity positively and significantly determine the exchange-rate volatility.

Nor, Masron and Alabdullah (2020) assessed the effect of macroeconomic factors on the volatility of Somalia's unregulated exchange rates using monthly data from January 1995 to December 2012. EGARCH (exponential generalized autoregressive conditional heteroskedastic) model was utilized and the study found that the unregulated exchange rate volatility of Somalia is influenced by its own shocks and the macroeconomic factors such as domestic price, imports, money supply, and hot money. The study also found that although Somali shilling circulated without regulatory authority for the period of the statelessness, this circulation has been accompanied by volatile exchange rates. However, this study focused on few macroeconomic factors

Chen, Du and Hu (2019) investigated the impact of Economic Policy Uncertainty (EPU) on China's exchange rate volatility from December 2001 to November 2018. The study used quantile regression and found that the impact of EPU on exchange rate volatility in China exhibits asymmetry as well as heterogeneity in different markets and that the EPU for China impacts positively and significantly on all quantiles volatilities of exchange rates. The study also found that EPU has a mixed effect on exchange rate volatility with apparent economy-by-economy differences. The US, Europe and Japan EPU have significant impacts, while Hong Kong EPU is insignificantly correlated with exchange rate volatility.

Udoh and Udeaja (2019) also investigated the relationship between financial dollarization and nominal exchange rate volatility in Nigeria using a Threshold Autoregressive Conditional Heteroscedasticity (TARCH) model on monthly data from December 2009 to September 2018. The study found that nominal exchange rate volatility in Nigeria is driven by the degree of financial dollarization and that exchange rate volatility exhibit high degree of persistence and ratchet effect. The study also found that bad news of depreciation in the nominal exchange rate trigger foreign currency holding which further depreciates the domestic currency exchange rate more than the good news of appreciation lead to further appreciation of the nominal exchange rate of the domestic currency.

Kilicarslan (2018) examined the determinants of exchange rate volatility to identify the factors affecting exchange rate volatility in Turkey from 1974 to 2016. The study used GARCH model to calculate the real effective exchange rate volatility and the Johansen cointegration test to determine whether there is a long-term relationship between variables while FMOLS method was used to determine the long-run relationship. The study found that that there is a long-run relationship between the variables involved in the analysis and that domestic investment, money supply and trade openness positively affects exchange rate volatility significantly while foreign direct investment, output, and government expenditure negatively affects real effective exchange rate volatility in Turkey.

Insah and Chiaraah (2013) determined the sources of exchange rate volatility in Ghana. The study used Autoregressive Distributed Lag (ADL) Model from 1980 to 2012. The study found that both domestic and external debts were negatively related to real exchange rate volatility while current external debt and a four year lag of domestic debt had significant impacts on real exchange rate volatility. The study however, neglected main determinants as proposed by the traditional theory of exchange rate in interrogating their significance.

Ajao (2015) examined the determinants of real exchange rate volatility in Nigeria from 1981 through 2008. GARCH (1,1) techniques was used to obtain the volatility of exchange rate and the ECM was used to examine the various determinants of exchange rate volatility in Nigeria while the co-integration analysis reveals the presence of a long term equilibrium relationship between real exchange rate volatility and its various determinants. The study found that openness of the economy, government expenditures, interest rate movements as well as the lagged exchange rate are among the major significant variables that influence real exchange rate volatility during this period.

On aspects of fluctuations in exchange rate, Rana, Anik and Biplob (2019) examined the main factors behind exchange rate fluctuations of Bangladesh from 1987 to 2017. The study used Johansen co-integrating test, VAR, Ganger causality test and

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FMOLS test. The study found no co-integrating equations for long run relationship but rather the short-run relationship. VAR model and Ganger causality test showed that that GDP growth and international trade positively affect exchange rate while remittance has negative effect on exchange rate

Studies have been carried out on exchange rate volatility in Nigeria such as Yinusa, 2008,olowe,2009,ogunleye.2009,Yinusa and Akinlo,2008,Akpokodje,2009,Aliyu,2009a,Aliyu,

2010, Adeoyeo and Atanda, 2011, Adeoye and Saibu, 2006, Adenekan,Sani and Itodo,2019.What we should understand is that studies on the determinants of exchange rate volatility are very few and most of the studies carried out observed limited number of factors and majority focus more on interrelationship of factors based on theories with little or no attention given to some important macroeconomic variables. This study departs from other studies based on the data coverage and macroeconomic variables used in the model unlike in other studies where only one set or few set of data is used.

## 3.0 METHODOLOGY

Methodology is a framework of procedures selected by a researcher to integrate diverse components of study in a sufficiently logical way in order to effectively address the research topic. There are several forms of research methods, including experimental, ex-post facto, survey, correlational, semi-experimental, or quasi-experimental study and review. Ex-post facto research approach is used in this work. It is often used to test ideas regarding cause-and-effect connections in place of actual experimental research. This research approach is recommended because it is the best design for dealing with the link between two or more variables in terms of cause and effect. The research also employs a descriptive and analytical approach. It is the most effective and reliable design for determining the source of any given effect. As a result, the research will include both descriptive and analytical methodologies. The analytical procedures include, of course, the unit root test, ARCHH/GARCH, Johansen test, and error correction test.

### 3.1 Theoretical Framework

The theoretical framework for this study is hinged on the traditional theory, monetary approach, portfolio balance theory and the Purchasing Power Parity (PPP) theory. To the traditional theory, exchange rate is determined by current account balance (Ogawa, 987). That is,

$$EXR = f(CAB) \quad (1)$$

Where, $EXR$ is the exchange rate and $CAB$ is the current account balance. However, current account balance is influenced by the relative prices ( $RP$ ) and income ( $Y$ ). That is,

$$CAB = f(RP, Y) \quad (2)$$

Thus, $EXR = f(RP, Y)$ (3)

The Purchasing Power Parity (PPP) theory also asserts that exchange rate is influenced by the national relative price level (Dornbusch, 1987; Officer, 1976). In other ways, the exchange rate is determined in the foreign exchange market, where dollars and other currencies are traded freely. That is, the effect of the balance of trade on the supply and demand for foreign exchange determines domestic currency exchange rate. As a result, when a country's trade account does not balance-that is, when exports exceed imports-there is relatively more supply or demand for that country's currency, which influences the price of that currency on the global market. Therefore, exchange rate is determined by Exports ( $EXPT$ ), Imports ( $IMPT$ ) and Income ( $Y$ ). equation (3) can be re-stated as:

$$EXR = f(EXPT, IMPT, Y)_{=} \text{ (TRDBAL)} \quad (4)$$

Improving exchange rate calls for concerted efforts for domestic price level or price level, income, interest rate. Exchange rate is determined by the nominal interest rate differential while a rise in the domestic price level relative to foreign prices leads to changes of the real exchange rate (Sundqvist, 2002). More so, higher interest rates offer lenders in an economy a higher return relative to other countries. Therefore, higher interest rates attract foreign capital and cause the exchange rate to rise and vice versa (Khan, 2010; Sundqvist, 2002). In international trade, the difference between export and import is called trade balance (Trade_bal). Therefore, export and import were replaced with Trade_bal in the equation (4) Therefore, equation (4) can be restated as:

$$EXR = (TRADE\_BAL, Y) \quad (5)$$

The modern theory also asserts that exchange rate is a function of relative shift in money stock, inflation rate and domestic output between a country and a trading partner economy (Allor, 2020). The inflation and income or output has also been identified by the

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traditional theory of exchange rate. Furthermore, the monetary model postulates three basic determinants of exchange rate as relative money supply and relative income (Allor, 2020). Hence, the equation (5) can be re-specified as:

$$EXR = f(TRADE\_BAL, Y, INF, M2) \quad (6)$$

The study incorporates the other determinants of exchange rate as explained by the Portfolio Balance theory. These include domestic money or monetary base, domestic bonds and foreign bonds, and government expenditure. Thus, incorporating the market capitalization in equation (6), the model becomes:

$$EXR = f(TRADE\_BAL, Y, INF, M2, MCAP, GOVEXP) \quad (7)$$

Specifying the equation (7) in a functional form and replacing Y for GDP (Gross Domestic Product), the equation can be re-stated as:

$$EXR = f(TRADE\_BAL, GDP, INF, M2, MCAP, GOVEXP) \quad (8)$$

Incorporating the exchange rate regime ( $EXRG$ ) as a dummy variable (DUMV) and excess reverses ( $ERES$ ), the equation (8) can be re-specified as:

$$EXR = f(TRADE\_BAL, GDP, INF, M2, MCAP, GOVEXP, DUMV, RES) \quad (9)$$

Where EXR is exchange rate, TRADE_BAL in trade balance, INF is inflation rate, M2 is Money Supply, MCAP is market capitalization, $GOVEXP$ is government expenditures, DUMV is exchange rate regime as represented by dummy variable and RES is the excess reserves.

**3.2 The Model for the Study/Model Specification**

To assess exchange rate volatility, the Autoregressive Conditional Heteroskedascity (ARCH) approach and GARCH will be utilised. Engle (1982) proposed ARCH models, which were generalised as GARCH (Generalized ARCH) by Bollerslev (1986) and Taylor (1988). (1986). The ARCH model will be used to test for the ARCH effect and assess whether or not the exchange rate is volatile. The Autoregressive Conditional Heteroskedasticity (ARCH) models were developed particularly to model and predict conditional variances. The dependent variable's variance is represented as a function of previous values of the dependent variable and independent, or exogenous, factors. The estimation equation is:

$$EXR_t = \alpha + \beta_1 EXR_{t-1} + \varepsilon_t \quad (10)$$

Where $EXR_t$ is the exchange rate series.

The squared of estimated residual ( $\varepsilon_t^2$ ) obtained in equation (10) is then regressed on its lag as follows:

$$\varepsilon_t^2 = \gamma_0 + \gamma_1 \varepsilon_{t-1}^2 + v_t \quad (11)$$

If the probability value of this test is smaller than any of the conventional statistical significance limits, the null hypothesis of no ARCH effects will be rejected (0.05). If the null hypothesis is rejected, it suggests the existence of the ARCH effect; otherwise, it implies the lack of the ARCH effect. The occurrence of volatility necessitates the use of ARCH-type models for estimate. Engle's (1982) ARCH model proposes that the variance of the residuals at time t () relies on the square of error terms from previous periods, implying that the variance is not constant. Two separate specifications are examined while creating an ARCH model: one for the conditional mean and the other for the conditional variance. As a result, the ARCH model is as follows:

Equation of Mean:

$$Y_t = X_t^1 \theta + \varepsilon_t \quad (12)$$

Variance Equation

$$\delta_t^2 = \alpha + \beta \varepsilon_{t-1}^2 + u_t \quad (13)$$

This analysis will also take into account Bollerslev's (1986) General Autoregressive Conditional Heteroskedascity (GARCH) model. It is a development of Engle's ARCH model. It accounts for the influence of variation on volatile time series in a way that the ARCH

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model does not. Both ARCH and GARCH have the identical mean equations, however the conditional variance equations vary. The estimate process for the GARCH model is the same as for the ARCH model; the only variation is the conditional variance equation,

which is shown below. $\delta_t^2 = \alpha + \beta_1 \varepsilon_{t-1}^2 + \beta_2 \delta_{t-1}^2 + u_t$ - - - - - - - - (14)

Where; $\varepsilon_{t-1}^2$ is the ARCH term and $\delta_{t-1}^2$ is the GARCH term. The closer the sum of the coefficients to 1, the slower the mean reverting and the closer the sum to 0, the faster the mean reverting.
In addition, Vector Error Correction (VECM) models will be used in the research to estimate and examine the drivers of exchange rates. The VECM models are least squares regressions using lags of both the dependent and explanatory variables as regressors (Greene, 2008). They are linear time series models in which the dependent and independent variables are connected not only in real time, but also through past (lagged) values. The general VECM model is as follows:

$$y_t = \alpha_0 + \alpha_1 t + \sum_{i=1}^{p} \psi_i y_{t-i} + \sum_{j=1}^{k} \sum_{l_j=0}^{q_i} \beta_{j,} l_j x_{j,t-l_j} \varepsilon_t + \Phi \text{ ECT}_{t-1} \quad (15)$$

where $\varepsilon_t$ are the usual innovations, $\alpha_0$ is a constant term, and $\alpha_1$, $\psi_i$ and $\beta_{j,} l_j$ are respectively the coefficients associated with a linear trend, lags of $y_t$, $\Phi$ the coefficients associated long adjustment and lags of the $k$ regressors $x_{j,t}$ for $j = 1,\ldots,k$.
Following the theoretical model as calibrated from the traditional theory, monetary approach, portfolio balance theory and the Purchasing Power Parity (PPP) theory as stated in equation (9), the model can be expressed in a functional form as:

$$EXRV = f(TRADE\_BAL, GDP, INF, M2, MCAP, GOVEXP, DUMV, RES) \quad (16)$$

Where EXRV represent exchange rate volatility. Thus, taking natural logarithm and specifying the stochastic form of equation (16), it can be restated as:

$$EXRV = \alpha 0 + \alpha 1 TRADE_{BAL} + \alpha 2 GDP, + \alpha 3 INF + \alpha 4 M2 + \alpha 5 MCAP + \alpha 6 GOVEXP + \alpha 7 DUMV + \alpha 8 RES + ú) \quad (17)$$

Where $\alpha_0$ is the intercept, $\alpha 1 - \alpha 8$ is the parameters to be estimated, $\ln$ is natural logarithm and $\mu$ is the stochastic error term. Thus, following a typical generalized ARDL $(p, q_1, q_2, \ldots, q_k)$ model is specified as:

$$y_t = \sum_{j=1}^{p} \delta_j y_{t-j} + \sum_{j=0}^{q} \beta_j^{'} X_{t-j} + \varepsilon_t + \Phi \text{ ECT}_{t-1} \quad (18)$$

Where $y_t$ is the dependent variable, $(X_t^{'})^{'}$ is a $k \times 1$ vector that are allowed to be purely $I(0)$ or $I(1)$ or co-integrated; $\delta_j$ is the coefficient of the lagged dependent variable called scalar; $\beta_j$ are the $k \times 1$ coefficient vectors; $p, q$ are optimal lag orders; $\varepsilon_t$ is the stochastic error term. And the reparameterised VECM $(p, q, q, \ldots, q)$ error correction model is specified as:

$$\Delta y_t = \theta \left[ y_{t-1} - \lambda^{'} X_t \right] + \sum_{j=1}^{p-1} \xi_j \Delta y_{t-j} + \sum_{j=0}^{q-1} \beta_j^{'} \Delta X_{t-j} + \varepsilon_t \quad (19)$$

Where
$\theta = -(1-\delta)$, group specific speed of adjustment coefficient (expected that $\theta \prec 0$)
$\lambda^{'}$ = vector of long-run relationships
$ECT = \left[ y_{t-1} - \lambda^{'} X_t \right]$, the error correction term
$\xi_j$, $\beta_j^{'}$ are the short-run dynamic coefficients
The dynamic equilibrium for the equation (17) can be specified as:

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Volume: 8| Issue: 8| August 2022|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

$EXRV = \alpha 0 + \alpha 1 inTRADE_{BAL} + \alpha in2GDP, + \alpha 3 inINF + \alpha 4 inM2 + \alpha 5 inMCAP + \alpha 6 inGOVEXP + \alpha 7 inDUMV + \alpha 8 inRES + \sum_{j-1}^{q} \alpha 8 in\, DUM + ú)$

$EXRV = \sum_{j-1}^{q} dEXRV + \sum_{j-1}^{q} \alpha 1 inTRADE\_BAL + \sum_{j-1}^{q} \alpha 2 inGDP + \sum_{j-1}^{q} \alpha 3 in\, INF + \sum_{j-1}^{q} \alpha 4 in\, M2 + \sum_{j-1}^{q} \alpha 5 in\, MCAP + \sum_{j-1}^{q} \alpha 6 in\, GOVEXP + \sum_{j-1}^{q} \alpha 7 in\, RES + \sum_{j-1}^{q} \alpha 8 in\, DUM + U$ (20)

And the error correction model of the equation (17) is written as:

$$EXRV = \boldsymbol{\theta} \sum_{j-1}^{q} dEXRV + \sum_{j-1}^{q} \alpha 1 inTRADE_{BAL} + \sum_{j-1}^{q} \alpha 2 inGDP + \sum_{j-1}^{q} \alpha 3 in\, INF + \sum_{j-1}^{q} \alpha 4 in\, M2 + \sum_{j-1}^{q} \alpha 5 in\, MCAP + \sum_{j-1}^{q} \alpha 6 inGOVEXP + \sum_{j-1}^{q} \alpha 7 in\, RES + \sum_{j-1}^{q} \alpha 8 in\, DUM + U \quad (21)$$

Where $\theta$ is the speed of adjustment coefficient that measures how long it takes the system for converge towards long-run equilibrium.

**A priori expectation**

The theoretical expectation is that imports of goods and services, inflation rate, interest rate, flexible exchange rate regime, and money supply will have a positive influence on exchange rate/exchange rate volatility, whereas exports of goods and services, market capitalization, foreign direct investment, fixed exchange rate regime, and foreign exchange reserves will have a negative influence.

**3.3 Explanations and Measurement of Variables**

**Trade balance** (TB as a proxy for imports and exports) Otherwise known as balance of trade Is the difference between the total value (in monetary terms) of a country's export and import for a given period of time usually a year, balance of a trade calculates or measures inflow of imports and outflow of export over a period of time ,the balance of trade of a country could either be positive or negative ,it depends on the position of exports and imports of a country, if for example if export is greater than imports then a country will experience positive trade balance surplus and on the other hand if country's import is greater than its export the trade balance will be in deficit or negative ,so balance of trade becomes favorable when the value of country's export is greater than the value of its imports and its equally determine how productive and import dependent a country is. For more understanding of the two components of trade balance an explanation on each is given below.

**Exports (EXPT**): The value of all products and other market services given to the rest of the world is represented by exports of commodities and services. They include the cost of goods, freight, insurance, transportation, travel, royalties, licencing fees, and other services including communication, construction, financial, information, business, personal, and government services. Employee remuneration, investment income (previously known as factor services), and transfer payments are not included. The data is in constant local currency (naira).

**Imports (IMPT):** The value of all products and other market services received from the rest of the world is represented by imports of goods and services. They include the cost of goods, freight, insurance, transportation, travel, royalties, licencing fees, and other services including communication, construction, financial, information, business, personal, and government services. Employee remuneration, investment income (previously known as factor services), and transfer payments are not included. The data is in constant local currency (naira).

However, trade balance (TRADE BAL) should be used as a proxy for both export and import since it shows the net value of both export and import.

**Gross Domestic Product (GDP):** GDP at purchaser prices is the total of the gross value contributed by all resident producers in the economy plus any product taxes and minus any subsidies not included in the product value. It is computed without regard for depreciation of manufactured assets or depletion and deterioration of natural resources. The data are in the current local currency (naira).

**Inflation (INF):** The rate of price change in the economy as measured by the yearly growth rate of the GDP implicit deflator. The GDP implicit deflator is defined as the ratio of GDP in constant local currency to GDP in current local currency.

**Broad Money Supply (M2**): This is the sum of currency outside banks, demand deposits other than those of the central government, time, savings, and foreign currency deposits of non-central government resident sectors, bank and traveler's checks, and other securities such as certificates of deposit and commercial paper.

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**Market capitalization (MCAP):** For listed domestic corporations, market capitalization (also known as market value) is the share price multiplied by the number of shares outstanding (including their various classes). Investment funds, unit trusts, and entities whose only purpose is to hold shares of other publicly traded firms are not eligible. The information is presented in local currency units (naira).

**Government expenditure:** Refers to the any amount of money expended by the public sector on provision of services like health care, education, social services, acquisition of goods and provision of defense, etc.

**Exchange Rate Regime (EXRG):** An exchange rate regime is the method through which a country's or currency union's monetary authority administers its currency in relation to other currencies and the foreign exchange market. There are two primary sorts of regimes: There is a floating (or flexible) exchange rate system in which currency rates are controlled purely by market forces and are often adjusted via open-market activities. Fixed (or pegged) exchange rate regimes emerge when a nation determines that the value of its own currency is directly related to the value of another currency or commodity. The intermediate regime is another regime that exists between the floating and fixed regimes. There are also floating exchange rate regimes (free float and managed float (or filthy float)), intermediate rate regimes (band (goal zone, crawling peg, crawling band, currency basket peg, and fixed exchange rate regime), and fixed exchange-rate systems (currency board, dollarisation and currency union). The research assigns a 1 if the object is free floating and a 0 otherwise.

**Foreign exchange reserves (RESV)**: Foreign exchange reserves are assets in foreign currencies maintained on reserve by a central bank. These reserves are utilised to back up obligations and have an impact on monetary policy. It includes any foreign currency owned by a central bank, such as Nigeria's Central Bank (CBN).

### 3.4 Data Sources Required

This research will rely on secondary data. These data will be sourced from the Central Bank of Nigeria Statistical Bulletin and the World Bank Development Indicators, and will include the exchange rate, exports of goods and services, imports of goods and services, inflation rate, interest rate, money supply, market capitalization, foreign direct investment, exchange rate regime, and excess reserves. The data comes in the form of quarterly data from 1981 to 2019.

### 3.5 Data Collection Method

Secondary data will be used in the research from the Central Bank of Nigeria Bulletin and the World Development Indicators website. As a result, the research will gather data via the internet and statistics bulletins.

### 3.6 Data Analysis Method

In order to analyse the data, the research will use both graphical and econometric methods. The graphical tools describe the main statistical properties of the data under examination and also give a historical context for our data's behaviour. Unit root tests, Autoregressive Conditional Heteroskedascity (ARCH)/GARCH technique, and VECM method are among the econometric instruments to be employed. The traditional unit root tests, specifically Augmented Dickey-Fuller (ADF) unit root tests, are among those evaluated. This will be used to determine the data's stationarity. The VECM approach will be used to investigate the long-run and short-run drivers of currency rate volatility in Nigeria. Method of Autoregressive Conditional Heteroskedascity (ARCH)/GARCH
After determining that there is volatility clustering in the series, the research will test and construct the exchange rate volatility series. Volatility testing of an ARCH-type models with two equations the mean equation and the variance equation. The AR components are captured by the mean equation, whereas the ARCH components are captured by the variance equation. The investigation will confirm the two basic characteristics of the volatility series of exchange rates. The investigation will also determine if the shock is permanent or transitory. That is, whether the impact of the shock on currency volatility is permanent or transient. The GARCH (1, 1) function will be used to test for volatility and generate the volatility series.

## 4.0ANALYSIS AND INTERPRETATION OF RESULTS

### 4.1Stationarity Test:

Since the data used in this study are time series, there is need to check the stationarity of the data. The stationarity properties of our data was checked using the Augmented Dickey Fuller (ADF) test (Dickey and Fuller 1979, 1981)

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**Table 4.1**

| Variable | Unit Root Tests(ADF) t-Statistic | 5% level of significance | Conclusion |
|---|---|---|---|
| **Exchange rate volatility** | - 4.257603 | -2.943427 | (1) |
| **GDP** | -8.244402 | -2.945842 | (1) |
| **GOVERNMENT_EXPENDITURE** | -6.681073 | -2.951125 | (1) |
| **INFLATION** | -8.413875 | -2.948404 | (1) |
| **M2** | -8.399201 | -2.945842 | (1) |
| **MCAP** | -7.131939 | -2.948404 | (1) |
| **RESERVES** | -4.414995 | -2.976263 | (1) |
| **TRADE_BALANCE** | -3.232678 | -2.967767 | (1) |

Check for the Unit Root the Augmented Dickey-Fuller unit root test was used to establish the order of integration and confirm the stationarity of the variables employed (ADF). Table 4.1 shows the results of the Augmented Dickey-Fuller unit root test. We cannot reject the null hypothesis of unit roots for the variables at their levels at the 5% significance level. However, stationarity was achieved after varying each variable once. This means that the variables are of order one integrated, I (1). This demonstrates that the variables are dynamic in nature and would be inappropriate for a static model. As a result, the use of a dynamic model such as the GARCH (1,1) in assessing the drivers of exchange rate volatility in Nigeria is justified.

**Table 4.2: Heteroskedasticity Test: ARCH**

| | | | |
|---|---|---|---|
| F-statistic | 6.544151 | Prob. F(1,150) | 0.0115 |
| Obs*R-squared | 6.354188 | Prob. Chi-Square(1) | 0.0117 |

Test Equation:
Dependent Variable: WGT_RESID^2
Method: Least Squares
Date: 10/15/21 Time: 22:45
Sample (adjusted): 1981Q1 2019Q4
Included observations: 152 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 0.798927 | 0.147438 | 5.418752 | 0.0000 |
| WGT_RESID^2(-1) | 0.204450 | 0.079921 | 2.558154 | 0.0115 |

| | | | |
|---|---|---|---|
| R-squared | 0.041804 | Mean dependent var | 1.004200 |
| Adjusted R-squared | 0.035416 | S.D. dependent var | 1.552685 |
| S.E. of regression | 1.524942 | Akaike info criterion | 3.694860 |
| Sum squared resid | 348.8171 | Schwarz criterion | 3.734648 |
| Log likelihood | -278.8094 | Hannan-Quinn criter. | 3.711023 |
| F-statistic | 6.544151 | Durbin-Watson stat | 2.001214 |
| Prob(F-statistic) | 0.011514 | | |

The data for the quarterly Naira/USD exchange rates used in this research were gathered. The data, which spans the years 1981 to 2019, came from the Central Bank of Nigeria (CBN) and the World Bank's online databases. As a standard precondition in the literature for dealing with volatile financial series, the pre-estimation analysis is carried out in three stages: the first provides descriptive statistics for the exchange rates under consideration; the second tests for the presence of structural breaks in the series; and the third tests for potential heteroscedasticity in the series using the ARCH LM test. A time series with autoregressive conditional heteroscedasticity (ARCH) effects exhibits conditional heteroscedasticity (or autocorrelation) in the squared series. To examine the likelihood of ARCH effects in the exchange rate series under examination, we use Engle's (1982) ARCH Lagrangian Multiplier (LM)

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
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test approach, which starts with a univariate model. The existence of effect in the model implies that negative shocks increase volatility more than positive shocks of the same size. If the sign of the p-value is statistically significant, negative shocks cause more volatility than positive shocks of the same size. As a result, the generalised autoregressive conditional heteroskedastic model (GARCH) will be utilised.

**4.2 Long-Run and Short-Run Analysis**

**Table 4.3: Johansen Co-integration Test**

Date: 10/19/21 Time: 13:41
Sample (adjusted): 1981Q1 2019Q4
Included observations: 100 after adjustments
Trend assumption: Linear deterministic trend
Series: EXCHANGE_RATE_VOLATILITY INFL_RATE LOGM2 LOGGDP GOV_EXPENDITURE LOGMCAP LOGRESERVE LOGTRADE_BALANCE DUMV
Lags interval (in first differences): 1 to 4

Unrestricted Cointegration Rank Test (Trace)

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.892075 | 633.9046 | 197.3709 | 0.0001 |
| At most 1 * | 0.765940 | 411.2724 | 159.5297 | 0.0000 |
| At most 2 * | 0.701532 | 266.0545 | 125.6154 | 0.0000 |
| At most 3 * | 0.421372 | 145.1452 | 95.75366 | 0.0000 |
| At most 4 * | 0.354482 | 90.43560 | 69.81889 | 0.0005 |

Trace test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Prob.** |
|---|---|---|---|---|
| None * | 0.892075 | 222.6322 | 58.43354 | 0.0000 |
| At most 1 * | 0.765940 | 145.2179 | 52.36261 | 0.0000 |
| At most 2 * | 0.701532 | 120.9093 | 46.23142 | 0.0000 |
| At most 3 * | 0.421372 | 54.70960 | 40.07757 | 0.0006 |
| At most 4 * | 0.354482 | 43.77019 | 33.87687 | 0.0024 |

Max-eigenvalue test indicates 5 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

A Johansen cointegration test was also performed to see if a linear combination of two or more variables integrated of the same order is stationary or whether a long run connection exists between the variables under examination. The optimal lag of the VECM model, however, was determined to be four (4,) using the Akaike Information criteria (AIC), which was thought to be the best criterion for selecting the optimum lag of sample sizes. The results reveal that both the Max-Eigen and Trace tests identify 5 cointegrating equations at the 5% level

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 8| Issue: 8| August 2022|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

| | | Vector Error Correction Estimates | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | Date: 10/19/21 Time: 14:20 | | | | | | | |
| | | Sample (adjusted): 1981Q1 2019Q4 | | | | | | | |
| | | Included observations: 100 after adjustments | | | | | | | |
| | | Standard errors in ( ) & t-statistics in | | | | | | | |
| Error Correction: | EXRATE_VOL | INFL_RATE | M2 | GDP | GOVEXPEND | MCAP | RESERVE | TRADE_BALANCE | DUMV |
| | | | | | | | | | |
| CointEq1 | -0.138 | -0.127 | 0.009 | 0.002 | 0.038 | -0.02 | -0.308 | 0.04 | 0.0024 |
| | -0.02 | -0.141 | -0.023 | -0.01 | -0.03 | -0.05 | -0.125 | -0.151 | -0.019 |
| | [-6.77370] | [-0.90] | [0.40] | [0.19] | [ 1.34] | [-0.43] | [-2.45] | [ 0.266] | [ 0.220] |
| | | | | | | | | | |
| EXRATE_VOL(-4)) | -0.339 | -0.29 | -0.08 | -0.05 | 0.264 | 0.082 | 0.244 | -0.931 | 0.0292 |
| | -0.077 | -0.532 | -0.086 | -0.05 | -0.11 | -0.19 | -0.473 | -0.57 | -0.041 |
| | [-4.402] | [-0.54] | [-0.93] | [-1.1] | [ 2.482 | [ 0.44] | [ 0.51] | [-1.633] | [ 0.711] |
| | | | | | | | | | |
| D(INFL_RATE(-4)) | 0.004 | -0.217 | -0.019 | 0.073 | 0.087 | -0.08 | -0.399 | 0.73 | -0.0248 |
| | -0.027 | -0.186 | -0.03 | -0.02 | -0.04 | -0.07 | -0.166 | -0.2 | -0.0144 |
| | [ 0.139] | [-1.16] | [-0.61] | [ 4.4] | [ 2.33] | [-1.27] | [-2.41] | [ 3.65] | [-1.72] |
| | | | | | | | | | |
| D(LOGM2(-4)) | 0.495 | -0.002 | -0.352 | -0.14 | -0.3 | 0.038 | 1.502 | -5.235 | 0.1074 |
| | -0.19 | -1.316 | -0.212 | -0.12 | -0.26 | -0.46 | -1.17 | -1.411 | -0.101 |
| | [ 2.602] | [-0.00] | [-1.7] | [-1.2] | [-1.14] | [ 0.08] | [ 1.28] | [-3.710] | [ 1.057] |
| | | | | | | | | | |
| D(GOV_EXPENDIT | -0.223 | -0.571 | 0.014 | -0.06 | -0.76 | -0.6 | 1.55 | -0.965 | 0.0148 |
| | -0.068 | -0.469 | -0.076 | -0.04 | -0.09 | -0.16 | -0.417 | -0.503 | -0.0362 |
| | [-3.28] | [-1.21] | [ 0.183] | [-1.4] | [-8.08] | [-3.65] | [ 3.71] | [-1.91] | [ 0.408] |
| | | | | | | | | | |
| D(LOGMCAP(-4)) | -0.109 | 0.393 | 0.106 | 0.026 | 0.159 | -0.34 | -0.12 | 0.922 | 0.0144 |
| | -0.049 | -0.341 | -0.055 | -0.03 | -0.07 | -0.12 | -0.303 | -0.365 | -0.026 |
| | [-2.20] | [ 1.15] | [ 0.92] | [ 0.8] | [ 2.33] | [-2.85] | [-0.39] | [ 2.523] | [ 0.549] |
| | | | | | | | | | |
| D(LOGRESERVE(-4 | -0.103 | 0.158 | 0.047 | 0.016 | -0.02 | -0.07 | -0.418 | 0.078 | -0.0164 |
| | -0.027 | -0.188 | -0.03 | -0.02 | -0.04 | -0.07 | -0.167 | -0.202 | -0.0145 |
| | [-3.80] | [ 0.837] | [ 1.55] | [ 0.9] | [-0.46] | [-1.01] | [-2.53] | [ 0.38] | [-1.13] |
| | | | | | | | | | |
| D(DUMV(-4)) | 0.286 | 0.74 | 0.122 | 0.039 | -0.13 | 0.007 | 1.223 | 1.905 | -0.3162 |
| | -0.114 | -0.789 | -0.127 | -0.07 | -0.16 | -0.28 | -0.701 | -0.846 | -0.0608 |
| | [ 2.50] | [ 0.93] | [ 0.95] | [ 0.6] | [-0.84] | [ 0.022 | [ 1.74] | [ 2.25] | [-5.19] |
| | | | | | | | | | |
| C | -0.005 | -0.011 | -0.003 | 0 | 0 | -0 | -0.026 | -0.02 | 0.0082 |
| | -0.003 | -0.02 | -0.003 | 0 | -0 | -0.01 | -0.018 | -0.021 | -0.0015 |
| | [-1.59] | [-0.54] | [-0.83] | [-0.4] | [ 0.026 | [-0.57] | [-1.51] | [-0.96] | [ 5.37] |
| | | | | | | | | | |
| R-squared | 0.896 | 0.67 | 0.695 | 0.814 | 0.843 | 0.763 | 0.793 | 0.894 | 0.9532 |
| Adj. R-squared | 0.832 | 0.464 | 0.506 | 0.698 | 0.745 | 0.615 | 0.663 | 0.827 | 0.924 |

**Interpretation of Result of Short-Run and long-run Relationship**

The estimated coefficients for the error-correction model are shown in the preceding table. The empirical model outperforms both theoretically and statistically. To begin, the ECT term's coefficient is statistically significant and negative in all cointegrating equations. These results suggest the existence of an equilibrium connection between the variables in each cointegrating equation. This means that ignoring the long run connection between variables would have resulted in misspecification of the underlying dynamic structure. The absolute values of the ECT component of each equation are used to calculate the monthly change in exchange rate due to the disequilibrium between the actual and equilibrium levels. The response pace to the previous period's disequilibrium varies significantly between interconnections. This means that the adjustment of exchange rate volatility to changes in the regressors might take anywhere between 3 and 6 months. The findings suggest that there are market dynamics in the foreign currency market that work to restore long-run equilibrium following a short-run disruption.

Second, almost all of the computed coefficients have the predicted signs, which is compatible with theoretical concerns. Money supply fluctuations are positively connected to variations in exchange rate volatility. The outcome of the previous period's exchange rate volatility also demonstrates that, in addition to its long-run influence, exchange rate volatility has a significant short-run effect on

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 8| Issue: 8| August 2022|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

GDP, market capitalisation, and government spending. Exchange rate volatility has a negative short-run association with reserves, government spending, market capitalisation, and trade balance, but a positive short-run link with money supply and inflation.

The Speed of Adjustment coefficient, i.e., the coefficient on the error correction term (ECT), is negative and statistically significant at the 1% significance level, indicating a long-run consistent link between exchange rate volatility and the right-hand side variables in Equations (1& 2). If there is a shock in the system, the negative sign implies a return to equilibrium. The findings reveal that in the short run, deviations from our long-run equilibrium are rectified at a rate ranging from 0.022 percent to 13% each year. In other words, it is projected that the exchange rate volatility will take somewhat more than a year and a half to recover to its equilibrium level after a shock in the system, which might have a detrimental influence on the economy's external competitiveness.

**Hypothesis**

Restatement of Hypothesis in Null and Alternate Form

**H0**: macroeconomic factors do not have positive and significant impact on Exchange Rate Volatility **H1:** Macroeconomic factors do have positive and significant impact on Exchange Rate Volatility

**4.3 Presentation of GARCH Result**

The table below presents the GARCH result for the test study hypothesis.

**Table 4.4**

**Dependent Variable: LOG(EXCH_RATE_VOLATILITY)**
**Method: ML ARCH - Normal distribution (BFGS / Marquardt steps)**
**Date: 10/15/21 Time: 23:16**
**Sample (adjusted): 1981Q1 2019Q4**
**Included observations: 153 after adjustments**
**improve likelihood (non-zero gradients) after 50 iterations**
**Coefficient covariance computed using outer product of gradients**
**Presample variance: backcast (parameter = 0.7)**
**GARCH = C(9) + C(10)*RESID(-1)^2 + C(11)*GARCH(-1) + C(12)*GARCH( -2)**

| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
|---|---|---|---|---|
| LOG(GDP) | -1.131564 | 0.030536 | -37.05613 | 0.0000 |
| LOG(GOVT_EXP) | 1.667877 | 0.034462 | 48.39730 | 0.0000 |
| LOG(INFL) | 0.185157 | 0.001289 | 143.6990 | 0.0000 |
| LOG(M2) | 0.384448 | 0.007240 | 53.10048 | 0.0000 |
| TRADE_BAL | -0.000781 | 0.000699 | -1.117466 | 0.2638 |
| RES | -2.28E-08 | 5.59E-09 | -4.079865 | 0.0000 |
| MCAP | -4.73E-05 | 2.65E-06 | -17.82762 | 0.0000 |
| C | 0.404162 | 0.058057 | 6.961467 | 0.0000 |
| **Variance Equation** | | | | |
| C | 0.000189 | 0.000138 | 1.372324 | 0.1700 |
| RESID(-1)^2 | 1.346417 | 0.324310 | 4.151635 | 0.0000 |
| GARCH(-1) | -0.157993 | 0.035933 | -4.396888 | 0.0000 |
| GARCH(-2) | 0.126326 | 0.059507 | 2.122881 | 0.0338 |

| | | | |
|---|---|---|---|
| R-squared | 0.598186 | Mean dependent var | 3.501496 |
| Adjusted R-squared | 0.576168 | S.D. dependent var | 1.925534 |
| S.E. of regression | 0.403133 | Akaike info criterion | -0.411255 |
| Sum squared resid | 23.56482 | Schwarz criterion | -0.173573 |
| Log likelihood | 43.46098 | Hannan-Quinn criter. | -0.314704 |
| Durbin-Watson stat | 2.048563 | | |

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**Interpretation of Result**

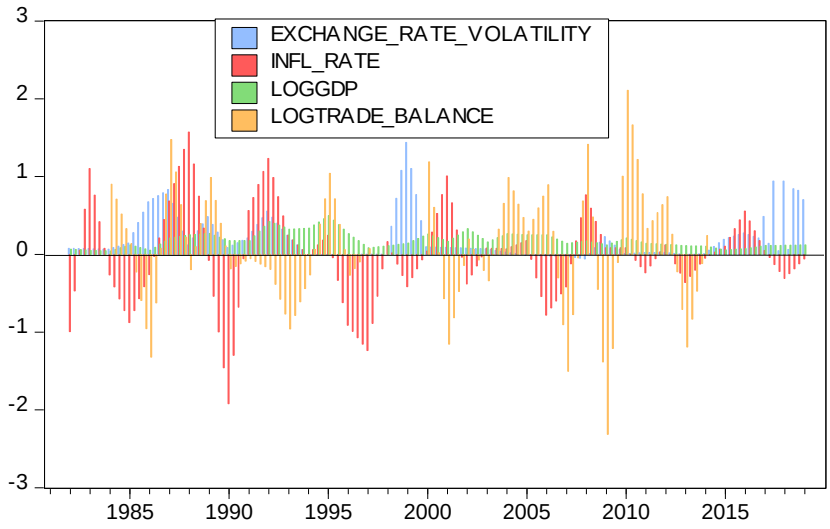
This hypothesis was used to test the impact of macroeconomic factors on exchange rate volatility Nigeria. Trade balance was adopted as proxy for both export and import. The GARCH mean equation results show that the coefficient of the macroeconomic variables such as GDP, INFL and MCAP as shown in table 4.6 had negative values and significant impact on mean value of exchange rate volatility except trade balance which is not statistically significant. All the other variables have positive impact. This shows that six variables in the model have significant impact on mean value of the volatility.

Volatility persistence measures the period of time required for volatility to dissipate or decay and it is computed by the sum of the coefficients of ARCH and GARCH effects. This shows that the coefficients of the GARCH and ARCH terms ($\beta_{2+}$ $\beta_3$) >1 in the model have long memory and volatility is persistent. Both GARCH and ARCH also are statistically significant given their p-values are below 5% level of significant. Since $\beta_2 + \beta_3 = 1.315$. The results also revealed that ARCH and coefficients of the GARCH terms are both positive and significant at 5 per cent level, which confirms the presence of volatility in the series. Following standard inferences from the literature, it suggests that there is greater indication of explosive level of persistence. Hence, we reject null hypothesis and conclude that macroeconomic variables do have impact on exchange rate volatility in Nigeria. This finding is consistent with a priori expectation, since volatility in exchange rate cause by activity of economic agents which both direct and indirect effect naira as a store of value, indirectly promote uncertainty among economic agents, and precipitate inflationary pressure. Specifically, in an import dependent economy like Nigeria, where wages are rigid, and exchange rate volatility promotes imported inflation that leads more volatility.

**Decision**

Given the fact that coefficient of exchange rate volatility as shown in the variance equation captured by GARCH and ARCH term (1.315) with the P value (0.0000) is less than the significance value (0.05), the result is consistent with a priori expectation, hence we reject null hypothesis and conclude that macroeconomic variables do have impact on exchange rate volatility in Nigeria.

GRAPHICAL ILLUSTRATION OF HOW MACROECONOMIC VARIABLES IMPACT ON EXCHANGE RATE VOLATILITY IN NIGERIA




The graph displayed above shows systematic relationships amongst macroeconomics variable and how they affect each other both in the short run and long run. The graph shows that GDP, inflation rate and trade balance all have significant impact of exchange volatility in Nigeria from 1981 to 2019 as shown on the graph above. The graph also shows that there is a complex relationship with amongst these macroeconomic variables which are sometimes direct and at other times indirect. Above all the graph shows that macroeconomic variables have significant impact on exchange rate volatility in Nigeria in the period under review as shown by the graph above.

**4.4 Post Estimation Test**

**4.4.1 Diagnostic Tests; ARCH Effect**

It is important to analyses the behavior of the model so as to determine the extent to which its results can be relied on. The necessity of diagnostic testing involves checking residuals of the series for any problems. Should problems be present, this may indicate that the

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EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 8| Issue: 8| August 2022|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

model is inefficient, and that parameter estimates may be biased. Diagnostic checks included for the purposes of this particular research are tests for serial correlation, heteroscedasticity, normality.

**Table 4.5**

**Heteroskedasticity Test: ARCH**

| | | | |
|---|---|---|---|
| **F-statistic** | **1.357195** | **Prob. F(20,112)** | **0.1595** |
| **Obs*R-squared** | **25.94537** | **Prob. Chi-Square(20)** | **0.1676** |

**Test Equation:**
**Dependent Variable: WGT_RESID^2**
**Method: Least Squares**
**Date: 10/15/21 Time: 23:41**
**Sample (adjusted): 1986Q1 2019Q4**
**Included observations: 133 after adjustments**

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| **C** | **0.923177** | **0.414611** | **2.226610** | **0.0280** |
| **WGT_RESID^2(-1)** | **0.362297** | **0.093992** | **3.854533** | **0.0002** |
| **WGT_RESID^2(-2)** | **-0.148206** | **0.099739** | **-1.485933** | **0.1401** |
| **WGT_RESID^2(-3)** | **-0.033986** | **0.098170** | **-0.346192** | **0.7298** |
| **WGT_RESID^2(-4)** | **-0.059248** | **0.097374** | **-0.608459** | **0.5441** |
| **WGT_RESID^2(-5)** | **-0.013631** | **0.097270** | **-0.140131** | **0.8888** |
| **WGT_RESID^2(-6)** | **0.050650** | **0.097301** | **0.520553** | **0.6037** |

| | | | |
|---|---|---|---|
| **R-squared** | **0.195078** | **Mean dependent var** | **1.127278** |
| **Adjusted R-squared** | **0.051342** | **S.D. dependent var** | **1.197229** |
| **S.E. of regression** | **1.166090** | **Akaike info criterion** | **3.289129** |
| **Sum squared resid** | **152.2939** | **Schwarz criterion** | **3.745500** |
| **Log likelihood** | **-197.7271** | **Hannan-Quinn criter.** | **3.474581** |
| **F-statistic** | **1.357195** | **Durbin-Watson stat** | **2.009980** |
| **Prob(F-statistic)** | **0.159524** | | |

The result of the ARCH test indicated absence of remaining ARCH effect as the Prob. Chi-Square is greater than 0.05, while the residual correlation test clearly indicated absence of autocorrelation as all the probabilities were evidently larger than 0.05 as shown in the table below.

**4.4.2 Residual correlation test**

**Table 4.6**

**Date: 10/12/21 Time: 19:54**
**Sample: 1981Q1 2019Q4**
**Included observations: 38**

| Autocorrelation | Partial Correlation | | AC | PAC | Q-Stat | Prob* |
|---|---|---|---|---|---|---|
| **. \| . \|** | **. \| . \|** | **1** | **-0.052** | **-0.052** | **0.1120** | **0.738** |
| **.*\| . \|** | **.*\| . \|** | **2** | **-0.103** | **-0.106** | **0.5587** | **0.756** |
| **.*\| . \|** | **.*\| . \|** | **3** | **-0.070** | **-0.083** | **0.7721** | **0.856** |
| **. \| . \|** | **. \| . \|** | **4** | **-0.031** | **-0.052** | **0.8142** | **0.937** |
| **. \|*. \|** | **. \|*. \|** | **5** | **0.165** | **0.147** | **2.0691** | **0.840** |

Serial correlation or autocorrelation arises when the error term observations in a regression are correlated. This error term indicates a random "shock" to the model, or anything that is absent from the model. If the error term observations follow a pattern, this pattern

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 8| Issue: 8| August 2022|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

will constitute evidence of autocorrelation. For each observation, the error term indicates the gap between the actual value of the dependent variable and the anticipated value. In the existence of serial correlation, then there will most likely be opportunities to enhance the model so that the regression performs a better job of predicting the dependent variable. A glance at the residual correlation test clearly demonstrated lack of autocorrelation as all the probabilities were definitely bigger than 0.05 showing that the model is adequately stated.

## 5.0 CONCLUSION AND RECOMMENDATIONS

Understanding exchange rate behaviour, with specific attention on how macroeconomic factors impact the degree and size of its volatility is vital for Nigeria, given its structural reliance on the external sector. An increased volatility in the exchange rate of the naira would raise great anxiety regarding the speculative assault and its associated bubble in the foreign currency market. The consequence is the bad impact on the growth of exports, production, and its potency at undermining the efficacy of monetary policy management, in light of the pass-through effects of exchange rate to domestic prices. To this regard, the policy goals, which are oriented at exchange rate stability, would benefit greatly from empirical research geared at exploring the influence of macroeconomic factors on exchange rate volatility in Nigeria and its consequence on the value of the naira.

### 5.1 Research Findings

The Summary of the outcomes is as follows:

a. That the coefficient most of the macroeconomic variables of had negative but substantial influence on exchange rate volatility

b. That the coefficient of inflation rate was negative and not-significant in explaining currency rate volatility in Nigeria.

c. That the money supply coefficient has a positive and considerable influence on exchange rate volatility in Nigeria.

d. Volatility persistence indicates the amount of time necessary for volatility to decay over time, which is calculated by adding the coefficients of the ARCH and GARCH effects. This demonstrates that the coefficients of the GARCH and ARCH terms are more than one (2+ 3) >1 in model 1, model 2, and model 3, and that the volatility is persistent.

f. At the 1% significance level, the coefficient of the error correction term (ECT) is negative and statistically significant, indicating a steady long-run link between exchange rate volatility and the right-hand side variables in Equations (1& 2). If there is a shock in the system, the negative sign implies a return to equilibrium. The findings reveal that in the short run, deviations from our long-run equilibrium are rectified at a rate ranging from 0.022 percent to 13% each year.

### 5.2 Comparison of Findings with Study Objective

This section relates the study's findings to the study's goals. The comparison is intended to offer proof that the aims of this research have been met ideally. As an example, consider the following:

**Research Objective**

The objective is fulfilled prudently, as shown by the regression findings from this research. According to the findings, macroeconomic factors have a detrimental influence on exchange rate volatility. The results are congruent with those of Hviding et al (2004) and Aranyarat (2007). These researchers agree that policies affecting macroeconomic factors should be consistent in order to preserve a stable exchange rate, which minimises uncertainty and stimulates current and future investment. Inconsistent policies, on the other hand, cause exchange rate volatility, which may amplify internal and external shocks and harm economic development. Domestic businesses in Nigeria, in particular, depend heavily on the foreign market for intermediate inputs; as a result, exchange rate fluctuation raises the cost of production and limits enterprises' capacity to expand output. Exchange rate volatility stymies economic progress by decreasing industrial capacity, signifying a currency crisis, a high level of uncertainty, precipitating internal and external shocks, and lowering trust in the economy.

The goal of this research is to look at the influence of macroeconomic factors on exchange rate volatility utilising five (5) important macroeconomic indicators. Economic growth, trade terms, government spending, trade flows, market capitalization, and external foreign reserves are all macroeconomic indicators. The generalised autoregressive heteroscedasticity (GARCH) estimation approach was used to attain these goals. Bollerslev (1986) generalised autoregressive heteroscedasticity (GARCH), a variation of Engel (1982) autoregressive heteroscedasticity (ARCH) model, was used to define the model. The GARCH model is justified because it has the ability to distinguish between predictable and unpredictable elements in the real exchange rate formation process, which is not prone to overstating volatility; a high-order ARCH model may have a more parsimonious GARCH representation that is much easier to identify and estimate, and because all coefficients must be positive, it ensures that the variance is finite, and all characteristics must lie within the univariate distribution. The study's results are quite fascinating, and they are primarily explained by the structure of the Nigerian economy. The findings revealed that macroeconomic factors had a detrimental influence on exchange rate volatility. As a result, future research should include more of the factors as important drivers.

ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 8| Issue: 8| August 2022|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

**5.3 Recommendations**

We suggest the following recommendations based on the study's findings:

**1. Maintain Exchange Rate Policies:**

This empirical research tells Nigerian policymakers that policy instability in relation to important macroeconomic factors causes exchange rate volatility. As a result, the Central Bank of Nigeria may lower the degree of exchange rate volatility through stabilising policies relating to main macroeconomic factors. In theory, the policy selected to stabilise important macroeconomic fundamentals, which favours a managed-float regime with a relatively limited fluctuation range, is reasonable and must be consistent.

**2. Create countercyclical fiscal buffers during economic expansion:**

The release of the findings, which revealed that exchange rate volatility is caused by trade balance and external foreign reserves, emphasises the necessity to accumulate reserves in order to properly protect the naira from swings. This might be accomplished by enhancing the mechanism for excess crude account (ECA). To be successful in developing fiscal buffers, crude oil revenues over the benchmark in the appropriation act must be put in the surplus crude account. The account might be ring-fenced by legislation such that it is only triggered during negative macroeconomic shocks. In this manner, the government might accumulate sufficient reserves to stabilise the foreign exchange.

**3. Diversification of the Nigerian Economy:**

Because the Nigerian economy is import reliant, the findings demonstrated a bidirectional association between exchange rate volatility and trade balance. This highlights the critical necessity to diversify the economy in order to improve exports. Essentially, the value of a country's currency is determined by its demand and convertibility. To stabilize the foreign exchange rate, the economy must be diversified, and intentional efforts must be made toward import substitution and export-oriented industrialization, both of which must generate foreign currency for the nation.

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ISSN (Online): 2455-3662
EPRA International Journal of Multidisciplinary Research (IJMR) - Peer Reviewed Journal
Volume: 8| Issue: 8| August 2022|| Journal DOI: 10.36713/epra2013 || SJIF Impact Factor 2022: 8.205 || ISI Value: 1.188

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