MIKAILALSYS
Journal of Multidisciplinary Sciences

e-ISSN : 2987-2286
p-ISSN : 2987-3924

Index : Dimensions, Scilit, Crossref, Garuda, Semantic, Lens,Google Scholar,Base, etc

https://doi.org/10.58578/mikailalsys.v2i2.3506

MODELLING THE DYNAMICS OF EXCHANGE RATES AND GDP IN NIGERIA: A SINGLE EQUATION ERROR CORRECTION MODEL (ECM) ANALYSIS

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Article Info:

Submitted:	Revised:	Accepted:	Published:
Jul 15, 2024	Jul 25, 2024	Jul 28, 2024	Jul 31, 2024

Abstract

This study evaluates the effect of exchange rates on Nigeria's economic growth between 1990 and 2020 was examined. The exchange rate was limited to the nominal exchange rate, and real gross domestic product was used as a proxy for the growth of the economy. Secondary data were collected from the Central Bank of Nigeria statistical bulletin for the period of the study. The OLS regression and Granger Causality test were used for analysis in the study. The findings demonstrated that one of the two explanatory variables, exchange rate, has a substantial significant effect on economic growth. The causality test also showed that there is two-way causality between exchange rate and the economic growth. The study concludes that increase when there is increase in exchange rate, the economic growth (GDP) will increase in Nigeria since exchange rate is and essential and significant predictor of economic growth.

Keywords: Exchange Rate, Cointegration, Inflation, Gross Domestic Product

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INTRODUCTION

Exchange rate is a significant macro-economic variable that affects economic growth, making it a crucial factor for economic development (Sankarkumar et al., 2019). It is the rate at which domestic currency is exchanged against a foreign currency, with a decline in currency value called depreciation (Uddin et al., 2014). Emerging economies rely heavily on imports and trade, making exchange rates crucial for their inclusive economy (Sankarkumar et al., 2019).

Exchange rate impacts economic growth, making it a focus of macroeconomists, policymakers, and central bankers (Uddin et al., 2014). A stable exchange rate is preferred over a volatile one, as fluctuations can lead to depreciation and economic instability (Danladi & Uba, 2016). Exchange rate affects the price of goods and services, influencing trade balances, investment, and economic growth (Ismaila, 2016). A competitive exchange rate can boost exports, attract foreign investment, and stimulate economic growth (Rapetti et al., 2011).

Nigeria's economy relies heavily on crude oil exports and imports, making it vulnerable to fluctuations in the US dollar (Anyanwu et al., 2017). The exchange rate policy has undergone significant transformations since independence, including a fixed parity with the British pound and a floating currency since 1986 (Akpan & Atan, 2012). The Naira has consistently depreciated against the US dollar, with significant economic repercussions (Anyanwu et al., 2017). The decline in oil prices and the COVID-19 pandemic have further exacerbated the economic challenges facing Nigeria (Ebenezer et al., 2022).

The country's reliance on imports and the absence of a diversified economy makes it vulnerable to exchange rate fluctuations (Ufoeze et al., 2018). The manufacturing sector has been severely affected by the exchange rate crisis, leading to a decline in production and employment (Kenny, 2019). The exchange rate crisis has also led to a decline in foreign investment, as investors seek more stable investment destinations (Sankarkumar et al., 2019).

Studies have shown conflicting results on the impact of exchange rates on economic growth (Rapetti et al., 2011; Uddin et al., 2014; Anyanwu et al., 2017; Ufoeze et al., 2018; Sankarkumar et al., 2019; Ebenezer et al., 2022). Some studies found a positive relationship between exchange rates and economic growth (Rapetti et al., 2011; Uddin et al., 2014), while others found a negative relationship (Anyanwu et al., 2017; Ufoeze et al., 2018). Some

studies found no significant relationship between exchange rates and economic growth (Sankarkumar et al., 2019; Ebenezer et al., 2022).

This study aims to determine the impact of exchange rates on economic growth in Nigeria, given the country's reliance on imports and exports and the controversial effectiveness of exchange rate policies. The study seeks to investigate the relationship between exchange rates and economic growth, analyze the effects of exchange rate fluctuations on the economy, and evaluate the effectiveness of exchange rate policies in achieving sustainable economic growth. The specific objectives of the study are as follows:

i. to determine the longtime effect of exchange rate on economic growth in Nigeria

ii. to examine the relationship between exchange rate and economic growth in Nigeria.

Exchange rate

Exchange rate refers to the price of one currency in terms of another, representing the ratio between a unit of one currency and the amount of another currency that can be exchanged at a particular time (Ngerebo-a and Ibe, 2013). It is the link between domestic and foreign prices of goods and services and can appreciate or depreciate (Mordi, 2006). Devaluation and depreciation are used interchangeably, with devaluation referring to a reduction in the value of a currency in terms of gold and depreciation referring to a reduction in value in terms of a specific foreign currency (Obadan, 2006).

There are two common concepts of exchange rate: nominal exchange rate (NER) and real exchange rate (RER). NER measures the relative price of two countries' moneys, while RER measures the relative price of two goods-tradable goods in relation to non-tradable goods (Obadan, 2006). The real effective exchange rate is a weighted average of bilateral real exchange rates, considering trade share of partners in total trade. Currency convertibility refers to the ease of converting a currency to other currencies without government restrictions.

Foreign Exchange Rate Management in Nigeria

Nigeria's exchange rate policy has undergone significant changes since 1960, from a fixed parity with the British Pound Sterling to a managed float regime. The naira was pegged to a basket of 12 currencies in 1978, but this was jettisoned in 1985 in favor of quoting the naira against the dollar. The Structural Adjustment Programme in 1986 led to the deregulation of

the naira and the introduction of the Second-tier Foreign Exchange Market (SFEM) to determine exchange rates and allocate foreign exchange.

Several modifications were made to achieve the objectives of SFEM, including the introduction of the Foreign Exchange Market (FEM), Autonomous Foreign Exchange Market (AFEM), Dutch Action System, and wholesale Dutch Auction System. The interbank foreign exchange market (IFEM) was reintroduced in 1999, and the Dutch Auction System (DAS) was reintroduced in 2002. As of 2023, Nigeria adopted the Managed Float Exchange Rate System, which aims to preserve the value of the domestic currency, maintain a favorable external reserves position, ensure external balance without compromising internal balance, and achieve macroeconomic stability (Oloko & Ogunsiji 2024).

Empirical Review

A plethora of studies have investigated the impact of exchange rates on economic growth in Nigeria and other countries. Ewubare and Ushie (2022) conducted a comprehensive study that spanned from 1981 to 2020, utilizing data from the Central Bank of Nigeria (CBN) Statistical Bulletin and World Development Indicators. Their analysis, which employed descriptive statistics, unit root tests, bounds cointegration tests, and ARDL models, revealed a significant positive effect of interest rates on GDP growth. The study recommends that the federal government, through the CBN, should ensure consistent exchange rate policies to provide opportunities for realistic and stable exchange rates, which can drive economic growth in Nigeria.

Mamuda et al. (2021) examined the impact of exchange rates on economic growth in Nigeria from 1986 to 2019, using secondary data sourced from the Central Bank of Nigeria. Their regression analysis, which employed ordinary least squares, revealed that exchange rates have a significant positive effect on economic growth, while interest rates and inflation rates have significant negative effects. The study concludes that exchange rates promote economic growth and recommends that the government encourage export promotion strategies and provide a conducive environment, adequate security, effective fiscal and monetary policies, and infrastructural facilities to attract foreign investors.

Karahan (2020) investigated the influence of exchange rates on economic growth in the Turkish economy, using quarterly data from 2002-Q1 to 2019-Q1. The study employed Johansen cointegration tests, Granger causality tests, and Innovation Accounting

Techniques, revealing a negative causal relationship between exchange rates and economic growth. The study argues that, even under the inflation-targeting regime in Turkey, both price and exchange rate stability should be provided together.

Musa (2019) estimated the impact of foreign exchange rates on economic growth in Nigeria, using an autoregressive distributed lag model (ARDL) on time series data from 1981 to 2017. The study found that real effective exchange rates are negative and significant in explaining GDP in Nigeria in the long run. In the short run, the lag value of real effective exchange rates is insignificant in explaining changes in GDP. The study concludes that the impact of foreign exchange rates on economic growth in Nigeria is negative and significant, and recommends that monetary authorities adopt flexible exchange rate policies.

Akpan et al. (2015) used the Generalized Method of Moments (GMM) and simultaneous equations model to investigate the impact of exchange rates on Nigeria's economic growth, using quarterly data from 1986 to 2014. The study found no direct relationship between exchange rates and economic growth, but rather that Nigeria's economic growth has been directly affected by monetary variables.

Eze and Okpala (2014) conducted a quantitative analysis of the impact of exchange rate policies on Nigeria's economic growth, using the Chow test procedure to determine the structural stability of the relationship between exchange rates and output of goods and services. The study found that, apart from government expenditure, both exchange rates and money supply are highly significant in determining Nigeria's economic growth performance. The study concludes that the relationship between exchange rates and economic growth performance in Nigeria has

Akpan and Atan (2011) investigated the effect of exchange rate movements on economic growth in Nigeria, using the Generalized Method of Moments (GMM) technique. The study found no evidence of a strong direct relationship between changes in exchange rates and output growth. Rather, Nigeria's economic growth has been directly affected by monetary variables.

Bakare (2011) carried out an empirical analysis examining the impact of exchange rate reforms on the performance of the Nigerian economy. The study found a significant but negative relationship between floating foreign exchange rates and private domestic investment in Nigeria. The study recommends that the government adopt a purchasing

power parity regime, which is considered more appropriate in determining realistic exchange rates for the naira and contributing positively to macroeconomic performances in Nigeria.

METHODS

Research Design and Data Source

This study employs a quasi-experimental research design, utilizing secondary data on all variables in the model to examine the effect of exchange rates on economic growth in Nigeria Time series data from 1990 to 2021 is used, covering the relevant time frame. Data on Gross Domestic Product (GDP) and exchange rates are collected from the Central Bank of Nigeria (CBN) statistical bulletin (2021).

Model Specification

The model for this study is specified to capture the relationship between economic growth, exchange rates, and inflation. The functional form of the model is:

$$GDP = f(EXR, \text{Inf}) \quad (1)$$

In a mathematical form, it is represented as:

$$GDP_t = \beta_0 + \beta_1 EXR_t + \beta_2 \text{Inf}_t + e_t \quad (2)$$

Where:

- GDP = Real Gross Domestic Product (a proxy for economic growth)
- EXR = Exchange Rates
- Inf = Inflation
- e_t = Error term
- t = Time period

A priori expectations: $\beta_0, and\ \beta_1 > 0$ (Gujarati & Porter, 2009; Wooldridge, 2016).

Method of Data Analysis

Several analytical techniques will be employed to appraise the effect of exchange rate on economic growth in Nigeria. These include:

i. Descriptive Statistics: To summarize the data using tables and statistical measures.

ii. Regression Analysis: To estimate the relationship between the dependent and independent variables.

iii. Unit Root Test: To check for the stationarity of the variables.

iv. Co-integration Test: To assess the long-run relationship between variables.

v. Granger Causality Test: To determine the direction of causality between variables.

vi. First Order Tests

a) **Student's t-test:** This test is used to determine the significance of individual regression coefficients. We use a 5% level of significance with $(n - k)$ degrees of freedom, where *n* is the number of observations, and *k* is the number of estimated parameters (Maddala & Lahiri, 2009).

b) **F-test:** This test evaluates the overall significance of the regression model. It tests the joint impact of the independent variables on the dependent variable. We use a 5% level of significance with $(k - 1, n - k)$ degrees of freedom, where $(V_1 = k - 1)$ and $(V_2 = n - k)$ (Greene, 2012).

Second Order Diagnostic Tests

After estimating the model, it is crucial to verify if the residuals satisfy the model's assumptions, particularly the absence of serial correlation, heteroscedasticity, and the normality of the residuals. This ensures the accuracy and reliability of the model (Brooks, 2019).

a) **Augmented Dickey-Fuller (ADF) Test**: This test checks for the presence of a unit root in macroeconomic variables. The ADF test specification is:

$$\Delta Y_t = \alpha + \beta t + \gamma Y_{t-1} + \delta \Delta Y_{t-1} + \dot{o}_t \qquad (3)$$

The null hypothesis is $(H_0 : \gamma = 0)$ (the series is non-stationary) against the alternative $(H_1 : \gamma < 0)$ (the series is stationary). The test statistic $DF_t = \frac{\hat{\gamma}}{se(\hat{\gamma})}$ is compared to the critical value from the Dickey-Fuller table (Enders, 2004).

b) **Durbin-Watson Test**: This test assesses the presence of autocorrelation in the residuals. The Durbin-Watson statistic is:

$$D^* = \frac{\sum_{t=2}^{T}(e_t - e_{t-1})^2}{\sum_{t=1}^{T} e_t^2} \quad (4)$$

Where:

- e_t = Residuals at time t

- e_{t-1} = Residuals at time t-1

The decision criteria are:

i. If $D^* < d_L$, reject the null hypothesis of no autocorrelation.

ii. If $(D^* > (4 - d_L)$, reject the null hypothesis of no autocorrelation.

iii. If $(d_U < D^* < (4 - d_U)$, accept the null hypothesis of no autocorrelation (Kennedy, 2008).

RESULTS AND DISCUSSION

Trend and Pattern of GDP, *Inf R* and *Ex R* in Nigeria:

This section presents the trends of the variables understudy. The individual stochastics fluctuations observed in the series is discussed.

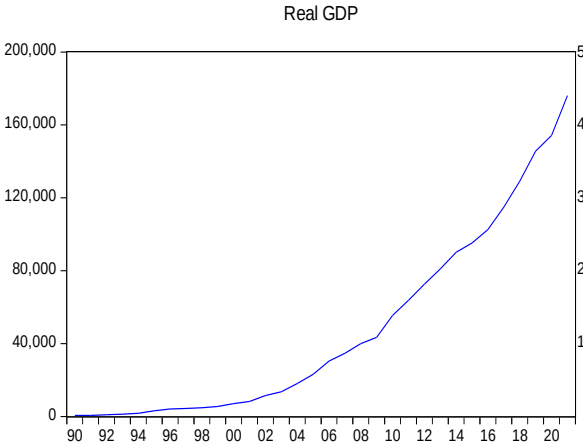


Figure 1: Gross Domestic in Nigeria

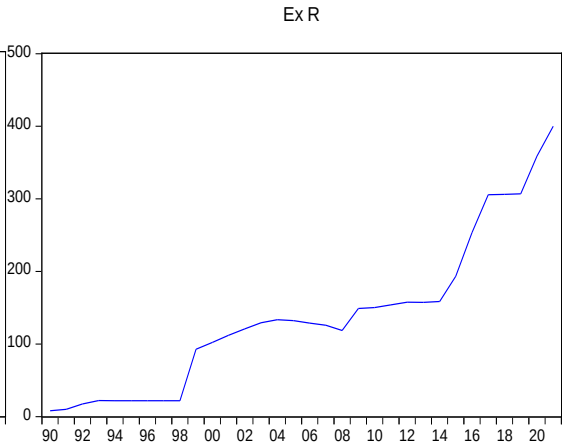


Figure 2: Exchange Rate in Nigeria

Figure 1 illustrates the trend of Nigeria's Gross Domestic Product (GDP) from 1990 to 2021. The trend reveals a steady and consistent upward trajectory, culminating in a peak in 2021. This suggests that Nigeria's GDP has experienced sustained growth over the past three decades, with each year building upon the previous year's progress. As GDP is a key output variable, it is reasonable to infer that certain input variables have had a positive impact on this growth.

Figure 2 displays the trend of the exchange rate in Nigeria over the same period. While some fluctuations are evident, the overall trend is unmistakably upward. Notably, the exchange rate remained relatively stable between 1992 and 1998, followed by a pronounced upward trend in subsequent years. This upward movement is characterized by increasingly higher highs over time, indicating a steady appreciation of the exchange rate.

These trends suggest a potential relationship between the exchange rate and GDP growth in Nigeria. As the exchange rate has appreciated over time, it is possible that this has positively impacted Nigeria's GDP, contributing to its steady growth. However, further analysis is necessary to fully understand the nature of this relationship and to identify any other input variables that may be influencing GDP growth.

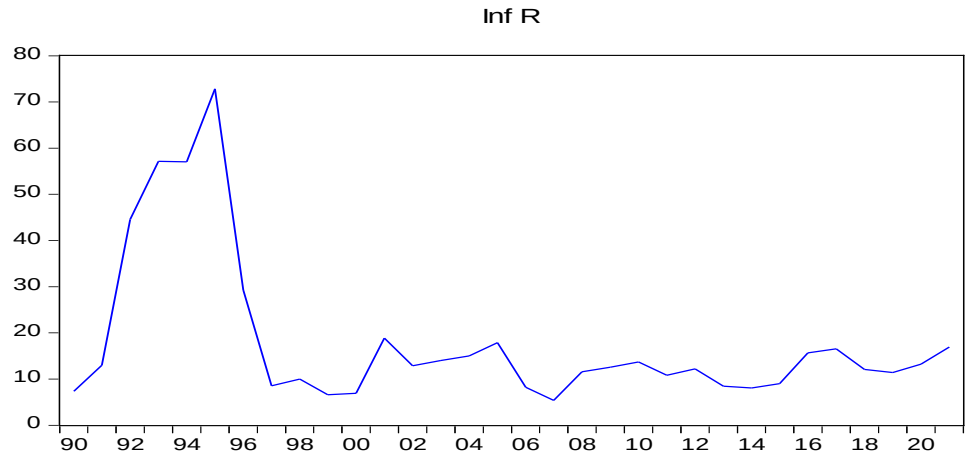


Figure 3: Inflation Rate in Nigeria

Figure 3 depicts the trend of inflation rates in Nigeria from 1990 to 2021. The graph reveals a relatively low and stable inflation rate in the early 1990s, followed by a sudden and significant spike in 1995. This sharp increase was short-lived, as the inflation rate plummeted between 1995 and 1996. From 1997 onwards, the inflation rate has fluctuated, exhibiting volatility that mirrors the pattern seen in Figure 1. This suggests that the inflation rate has been subject to various economic shocks and fluctuations over the past

few decades, potentially influencing the overall economic growth and GDP trend observed in Figure 1. The oscillating nature of inflation rates may have contributed to the fluctuations in GDP growth, highlighting the complex interplay between economic indicators.

Stochastic and Co-Integration Properties of the Series

This study examined the stochastic properties of the exchange rate and economic growth time series in Nigeria to better understand their relationship. To achieve this, various statistical techniques were employed, including stationarity tests (Augmented Dickey-Fuller), autocorrelation and partial autocorrelation analysis, Granger causality tests, and co-integration tests. These analyses aimed to determine if the series were stationary or non-stationary, examine the correlation between the series and its lagged values, assess the directional relationship between exchange rates and economic growth, and determine if a long-run equilibrium relationship exists between the two series. The results of these analyses are presented in this section, providing insights into the stochastic properties of the series and the impact of exchange rates on Nigeria's economic growth.

Table 1: Stationarity Test

	Level ADF	First Difference ADF	Second Difference ADF	Order of Integration
GDP	-2.674091	0.052044	-8.872136	I(2)
Ex R	1.842870	-3.765563		I(1)
Inf R	-2.118861	-4.511443		I(1)

Table 1 displays the results of the stationarity test, which employed the Augmented Dickey-Fuller (ADF) test to examine the null hypothesis of a unit root against the alternative hypothesis of stationarity. The test statistics, presented in Table 1, were used to make decisions regarding the hypotheses. The results indicate that all variables exhibit unit roots at a 5% level of significance, suggesting non-stationarity. However, upon taking the first difference, all variables become stationary, except for GDP, which requires a second difference to achieve stationarity. This reveals that the variables are integrated of order one, I(1), and I(2) for GDP. Subsequently, a check for co-integrating vectors among the variables was conducted to determine if a long-run equilibrium exists among them. The cointegration result provides insight into this relationship.

Table 2: Test for Cointegration

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.727519	55.13734	29.79707	0.0000
At most 1 *	0.354407	16.13171	15.49471	0.0401
At most 2	0.095287	3.004138	3.841466	0.0830

Trace test indicates 2 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

The non-stationarity of the variables in their level form suggests the possibility of a cointegrating relationship between them. To further investigate, a cointegration test was conducted, and the results are presented in Table 2. The trace test reveals the presence of one cointegrating equation at a 5% level of significance, confirming the findings from the previous stationarity test. This indicates that despite the individual non-stationarity of the variables, there exists a long-run equilibrium relationship between them, supporting the possibility of a cointegrating relationship.

Table 3: Long Run Regression Equation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
LOG(*Inf R*)	-0.035321	0.290970	-0.121390	0.9042
LOG(*Ex R*)	1.532140	0.179587	8.531440	0.0000
C	3.087584	1.382708	2.232997	0.0337
R-squared	0.871949	Mean dependent var		9.887482
Adjusted R-squared	0.862803	S.D. dependent var		1.675097
S.E. of regression	0.620458	Sum squared resid		10.77911
Long-run variance	0.803525			

The confirmation of cointegration indicates a long-run equilibrium relationship between the variables, suggesting that they move together over time. Table 3 presents the estimated long-run relationship between GDP, ExR, and InfR, with GDP as the dependent variable. The regression analysis reveals that ExR has a significant positive impact on economic

growth, implying that a 1% increase in ExR leads to a corresponding increase in GDP. This suggests that exchange rate changes have a profound influence on Nigeria's economic growth.

The *R*-squared value of 0.871949 indicates that approximately 87.1% of the variation in GDP can be explained by the explanatory variables, highlighting the robustness of the model. This suggests that the long-run relationship between GDP, ExR, and InfR is strong and stable.

Furthermore, the normality of the residuals was tested to ensure that the regression assumptions are met. The results, presented in Figure 4, confirm that the residuals are normally distributed, supporting the validity of the regression model and the conclusions drawn from it. This implies that the model is reliable and can be used for predictive purposes. The results of the normality test revealed a skewness value of -0.624050 and a kurtosis value of 2.472295, with a Jarque-Bera statistic of 2.371794. These metrics suggest that the residuals are approximately normally distributed. Furthermore, the probability value of 0.305472, which is greater than the 5% significance level, indicates that we cannot reject the null hypothesis of normality for the residual series. Therefore, we can conclude that the residuals are statistically normal, supporting the assumption of normality in the regression model.

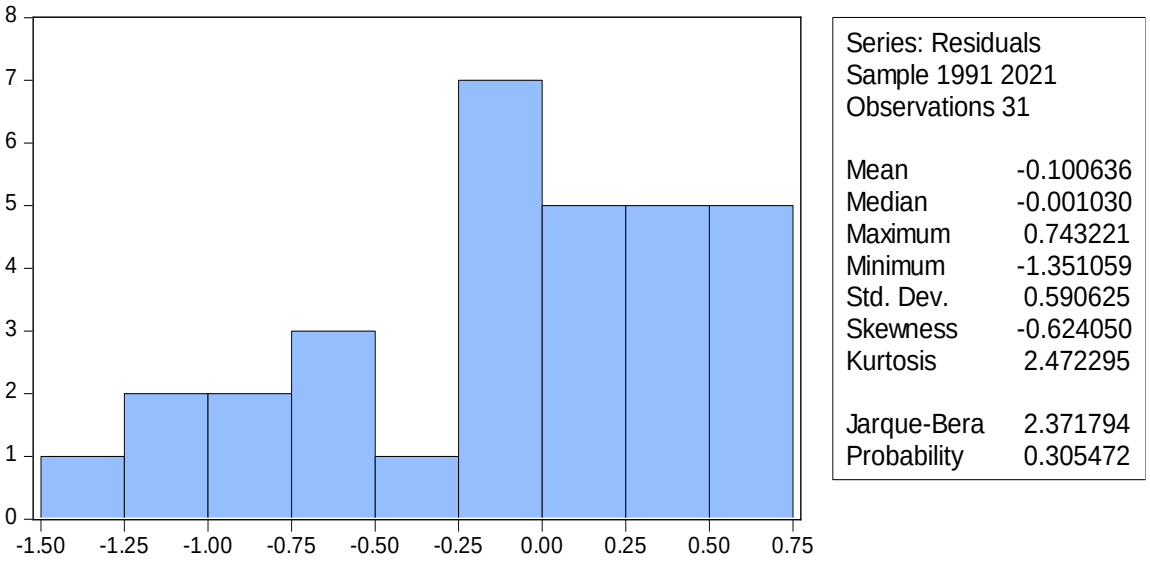


Figure 4: Histogram of Residuals

Causality Test

The direction of causality between the variables was investigated using the Granger-causality test, which examines whether one variable can predict another variable's future values. The results of the test are presented in the table below, providing insights into the causal relationships between the variables:

Table 4: Short-run Causality Test

Null Hypothesis:	Obs	F-Statistic	Prob.
INF_R does not Granger Cause REAL GDP	30	0.12352	0.8843
REAL_GDP does not Granger Cause *Inf R*		1.16026	0.3297
EX_R does not Granger Cause REAL_GDP	30	6.12345	0.0068
REAL_GDP does not Granger Cause *Ex R*		4.74483	0.0179
EX_R does not Granger Cause *Inf R*	30	0.82256	0.4508
INF_R does not Granger Cause *Ex R*		0.68226	0.5146

The Granger causality test (presented in Table 4) requires stationarity of the variables. Since our variables were integrated of order one, we employed the test to examine short-run causal relationships. The results revealed no short-run causality between InfR and GDP, indicating that changes in GDP do not lead to changes in InfR, and vice versa, in the short term. However, we found bidirectional causality between ExR and GDP, suggesting that changes in ExR lead to changes in GDP, and changes in GDP also lead to changes in ExR, in the short run.

CONCLUSION

This study investigated the impact of exchange rates on Nigeria's economic growth between 1990 and 2020. The analysis used real GDP as a proxy for economic growth and nominal exchange rate as the exchange rate variable. The study reviewed relevant theories and empirical literature, and employed the Augmented Dickey Fuller test and Johansen Cointegration test to examine the stationarity and long-run relationships between the

variables. The results showed that exchange rate (Ex R) has a significant positive impact on economic growth, and there is bidirectional causality between Ex R and GDP.

Recommendations

Based on the findings, the study concludes that exchange rate is a crucial predictor of economic growth in Nigeria, and an increase in exchange rate leads to an increase in economic growth.

i. Effective management of exchange rate is essential to boost productivity in the economic sector and other sectors.

ii. Policymakers should demonstrate high capacity in managing exchange rates to achieve economic development and its multiplier effects. Strategic planning and execution are crucial in this regard.

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