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Full Length Research Article

# ECONOMETRIC MODELLING OF NIGERIA ECONOMIC GROWTH: A VECM AND IMPULSE RESPONSE FUNCTIONS

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**ABSTRACT**
Economic growth characterizes the quantitative changes that occur in economic variables and attributed to overall increase in production per capital. This study examined the economic impact of exchange rate, foreign direct investment, inflation rate and the trade balance on Nigeria GDP over the period of 1970-2022. The dynamic causal association among the selected macroeconomic variables and economic growth in Nigeria was evaluated via the implementation of vector error correction model (VECM) procedures and impulse response functions. The VECM estimates and the impulse response shows that the response of GDP to inflation and exchange rates is positive while the response of GDP to a one period shock to the trade balance yields a marginal negative depreciation. The result justifies that the place of Exchange rate, Inflation and Trade Balance to Nigeria economic growth cannot be overstated. The results of the work suggest that to promote stable and sustainable economic growth, policy makers should lay more emphasis on encouraging stable and reasonable exchange rate. Also, the work recommends that to promote economic growth and keep inflation low in Nigeria, Anti-inflationary policies should be accompanied to attract foreign investors and frustrate capital fleeing from the country.

**Keywords**: Economic Growth, Vector Error Correction Model, VAR model and Impulse Response Functions.

## INTRODUCTION

Economic growth is a central objective for countries seeking to improve the standard of living and well-being of their citizens. Economic growth is one of the essential macroeconomic coverage targets in which countries all over the world persistently strive to achieve and Nigeria is not an exception (Adeleke *et al* 2014). For nations like Nigeria, located in the African continent with abundant natural resources and a large population, achieving sustained and inclusive economic growth is of paramount importance. Over the years, Nigeria has experienced various economic challenges and opportunities that have shaped its economic performance. Fluctuations in key macroeconomic variables have contributed to the country's economic instability and hindered its progress towards long-term growth targets

Empirical evidence (Akpan and Eweke(2017); Adeleke *et al* 2014; Alushi 2016, Ndubuisi, 2017, Adewole *et al,*. (2018)) on the subject showed that there are mixed results or inconsistent findings. This could be attributed to econometric tests employed, sources of data and coverage of data. Hence, these differences demand further study on macroeconomic determining factors of economic growth in Nigeria. This study employed econometric tools in estimating and analyzing the empirical causal relationship among Nigeria-exchange rate, interest rate, inflation rate, FDI, Trade balance and GDP. These variables play a crucial role in influencing the overall economic performance of the country. For instance, GDP is a measure of the total economic output of a nation and is often used as a primary indicator of economic growth. Inflation rates reflect the general price level of goods and services and can have implications for purchasing power and economic stability. Interest rates, set by the central bank, influence borrowing costs and investments. Exchange rates determine the value of the local currency relative to foreign currencies and have implications for international trade and competitiveness. FDI inflows aids perfect flow of capital, technology, and expertise, it also helps in stimulating various sectors and creating employment opportunities. Lastly, the trade balance, which is the difference between a country's exports and imports, reflects its international trade position and economic integration.

Econometrics is a powerful tool that enables researchers to estimate and quantify the relationships between economic variables and examine their causal impact (Greene 2012). This work examines the dynamic causal association among selected macroeconomic variables and economic growth in Nigeria via the implementation of vector error correction model (VECM) and impulse response functions. Vector Error Correction Model (VECM) is a long term cointegrated Vector Autoregressive (VAR) which can be employed for non-stationary data series. The VECM models helps in examining effect of one variable movement yielding response to shocks generated by the other variable through the use of Impulse Response Function (IRF)graph, The standard VAR (Vector Autoregression) models' estimation can only be derived when the variables are stationary however, VECM model were introduced insinuating that not all variable are stationary, (Medvegyef (2015). The use of Vector Autoregressive Models (VAR) and Vector Error Correction Models (VECM) for analyzing dynamic relationships among financial variables has become common in the literature, Granger (1981), Engle and Granger (1987), Dalina and Liviu(2015), Adewole *et al.*, (2020) Al-Masbhi and Du, (2021) among others. The popularity of these models can be traced to shortfalls of convectional time series models in capturing the interrelationship among complex financial variables. Lakshmanasamy (2022) modelled the economic performance of inflation and other macroeconomic variables on India economic growth using VECM. The results show the significance of inflation on India Economic growth and suggest that money supply and budget deficits need to be rationalized to promote economic growth. Ukwanga and Ikechi (2022) studied the impact of exchange rate on rate of economic growth in Nigeria, error correction model was applied in their study, their result concluded that import, export and money supply has a positive relationship with economic growth. Their study also revealed that Naira rate has no significant influence on economic growth in Nigeria Empirical evidences revealed no persistence results recorded under the VECM framework and examinations of

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response shocks in the models. This study therefore attempts to revisits study of the econometric analysis on the interplay between tremendous macroeconomic key variables and economic growth in Nigeria, providing valuable insights for policymakers and stakeholders with the application of Vector Error Correction Model (VECM), IRF graphs and forecast error variance decompositions. The research thus investigated the dynamic causal relationship among the variable under study and thus analyses the significance of the forecast error in the economic variable by other macroeconomic variables.

## MATERIAL AND METHODS

Annual data set covering the period ranging from 1970 to 2022 was employed in this research obtained from Nigeria CBN bulletin which comprised figures of Gross Domestic Product (GDP) per capital ( $y_t$ ), exchange rate $(x_1)$, foreign direct investment$(x_2)$, Inflation rate $(x_3)$, and Trade balance $(x_5)$ was used in modelling equation **(1)** below to examine the causal relationship among the variables in Nigeria.

$$y_t = \beta_1 x_t + \beta_2 x_t + \beta_3 x_t + \beta_4 x_t + u_t \qquad (1)$$

The theoretical model, which also serves as a basic frame work of the statistical analysis, is the Vector Autoregressive model of order p. VAR models are built based on the economic variables that are assumed to be stationary

### Augmented Dickey-Fuller Test

Stationarity of a series is an important phenomenon because of its influence behavior on statistics inference. Most of economic variables are non-stationary in nature, Granger and Newbold (1974) ascertained that the regression inferences from the VECM models of the Granger causality tests using non-stationary variables will be spurious. Augmented Dickey-Fuller tests was employed to test for the presence of unit roots in the data before generalizing any relationship.

The Augmented Dickey-Fuller (ADF) test is a unit root test where lagged terms are added to the *Y* variable to remove possible autocorrelation. The number of lags is determined by the Akaike information criterion (AIC) or Bayesian information criterion (BIC}. The test has the following form

$$\Delta Y_t = \alpha_0 + \beta_1 t + \phi Y_{t-j} + \sum_{j=1}^{m} \mu_j \Delta Y_{t-j} + \epsilon_t \qquad (2)$$

Where t = m+1………T

and $\alpha$ is a constant and $\beta$ is the coefficient of time trend. $\sum_{j=1}^{m} \mu_j \Delta Y_{t-j}$ is the sum of the differentiated lagged *Y*s together with their coefficients, m lags of $\Delta Y_{t-j}$ are added to remove serial correlation in the residuals.

The null hypothesis of the test is, $\phi = 0$ and the alternative hypothesis $\phi$ < 1. When the null hypothesis is being rejected indicates $Y_t$ does not exhibit a unit root and therefore is stationary otherwise not stationary. The hypothesis is tested on the basic principle of t-statistic of the coefficient $\phi$. This is obtained by comparing the ADF test statistic with a critical value at a given significance level.

**VAR Lag Length Selection:** The optimal lag for the variables is determined by certain model selection criteria like the Akaike's information criterion (AIC), Schwarz information criterion (SIC) and Hannan-Quinn information criterion (HQIC) minimum values were used.

**Granger-Causality:** A general specification of the Granger causality test in a bivariate (X, Y) context can be expressed as:

$$y_t = \sum_{i=1}^{a} \alpha_i x_{t-i} + \sum_{i=1}^{b} \beta_j y_{t-j} + \varepsilon_{1t} \qquad (9)$$

$$x_t = \sum_{i=1}^{a} \delta_i x_{t-i} + \sum_{i=1}^{b} \varphi_j y_{t-j} + \varepsilon_{2t} \qquad (10)$$

where a is the maximum number of lagged observations included in the model. The significance of the coefficients $\alpha, \beta, \delta$ *and* $\varphi$ determine the direction of causality and the coefficients are jointly tested for their significance. Two different causality tests can be obtained from the analysis in equation 9 and 10 above; the first scenario examines the null hypothesis that the $x$ does not Granger-cause $y$ while the second scenario examines the null hypothesis that the y does not Granger-cause $x$. If there is acceptance of the former null hypothesis and reject the latter, then there will be conclusion of $x$ changes are Granger-caused by a change in $y$. Unidirectional causality occurs between two variables when either null hypothesis of equation (9) or (10) is rejected. Bidirectional causality occurs when there is rejection of both null hypotheses and no causality exists if neither null hypothesis of equation (9) nor (10) is rejected.

### Vector Autoregression (VAR)

Vector Autoregression (VAR) models is a broad structure purposed in modelling the joint dynamics and causal relations among a set of stationary macroeconomic variables (Christopher Sims (1980) Considering a VAR(P) model as;

$$Y_t = \alpha_o + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} +, \dots, \phi_p Y_{t-p} + \epsilon_t \qquad (11)$$

where $Y_t = [Y_{it}, \dots, Y_{kt}]^{\text{ɩ}}$ is a $(k \times 1)$ random vector, the $\phi_i$ are fixed $(k \times k)$ coefficient matrices, $\alpha_o$ is a $(k \times 1)$ vector of constants that allows existence of non zero mean E$(Y_t)$.The vector autoregressive (VAR) model is a general framework used in depicting the dynamic association among stationary variables. The first phase in time-series analysis is checking the stationary level of the data are stationary. However, If there are nonstationary times series data, then is of necessity for the VAR framework to be modified to permit consistent estimation of the relationships amidst the series.

### Vector Error Correction (VEC) Model Estimation.

The vector error correction (VEC) model is a specific situation of the VAR for variables that are made stationary in their differences (i.e., I(1)). The VEC model can consider any cointegrating associations among variables, the appropriate VECM model can be formulated as

$$\triangle y_t = \alpha \beta^{\text{I}} y_{t-1} + \sum_{i=1}^{p-1} \Gamma_i \triangle y_{t-1} + \mathcal{E}_t \qquad (12)$$

where

$\triangle$ is the operator differencing

$\triangle y_t \equiv y_{t-} y_{t-1}$

$y_{t-1}$ = vector variable endogenous with the 1st Lag

$\mathcal{E}_t$ is the vector residual

$\Gamma_i$ is matrix with order k x k of coefficient endogenous of the i-th variable.

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$\alpha$ is the vector adjustment matrix with order (Kx r).
Estimating Vector Error Correction Model
A VEC model was estimated for co-integrated variables based on annual data ranging from 1970 to 2022 to examine short-run and long-run causal relationship among the co-integrating variables. The significance of the Error Correction (EC) term determines the long-run relationship, and summing of lagged coefficients of the independent variables demonstrates the short-run causal relationship at conventional level of significance. The traditional way of removing unit root model is to first differentiate the series. However, in the case of cointegrated series, it has deficiency of yielding over differencing and losing information obtained from long-term co-movement of variable levels. The Vector Error Correction Model (VECM) was employed for the analysis because it restricts the long run behavior of the dependent variables in converging to their cointegrating relation, though permitting a short run adjustment (Gujaratti,2003). VECM Model adequacy was verified employing different diagnostic check like the Jarque Bera test for normality, white test for heteroskedacity and Breusch Godfrey test for serial correlation.

**Stability of the Model**
The condition for stability of VAR model according to Lutkepohl (2005) is VAR model is assumed to be stationary if all the inverse roots of all the characteristics polynomial of AR have a modulus that is less than one and are all contained in the unit circle.
Considering the Var (p)

$$Y_t = \alpha_o + \phi_1 Y_{t-1} + \phi_2 Y_{t-2} +, \ldots, \phi_p Y_{t-p} + \epsilon_t \quad (13)$$

If t=1, then we have

$$Y_t = \alpha_o + \phi_1 Y_o + \epsilon_1 \quad (14)$$

$$Y_2 = \alpha_o + \phi_1 Y_1 + \; + \epsilon_2 \quad (15)$$

Substituting equation (14) into (15), we have;

$$Y_2 = \alpha_o + \phi_1 (\alpha_0 + \phi_1 Y_o + \epsilon_1) + \epsilon_2 \quad (16)$$

$$= (I_k + \phi_1)\alpha_o + \emptyset_1^2 Y_o + \phi_1 \varepsilon_1 + \varepsilon_2$$

. . .
. . .
. . .

$$Y_t = (I_k + \phi_1 +, \ldots, \emptyset_1^{t-1})\alpha_o + \emptyset_1^t Y_o + \sum_{i=0}^{t} \emptyset_1^{\iota} \varepsilon_{t-i}$$
(17)

However, the model in equation (w) is stable if the reverse characteristics polynomial has no roots in the complex unit circle. The stability condition of Var (p) is thus defined as;

$$\det(I_{kp} + \phi_Z) = \det(I_k - \phi_Z, \ldots, \phi_p^{ZP}) \quad (18)$$

Provided that $|Z| \leq 1$.

**Impulse Response Function**
impulse response function trail the incremental effect sequel to a shock of an endogenous variable on itself or on the impending values of the other endogenous variables [Petersen and Kumar (2012),]. Impulse response functions are used to examined the effects of shocks in a VAR or VEC model.
Considering the VAR(p) model that assumes stationarity

$$Y_t = \alpha_o + \alpha_1 Y_{t-1} + \epsilon_t \quad (19)$$

Where $\alpha_o = C^{-1}\Gamma_0$
$\alpha_1 = C^{-1}\Gamma_1$
$\varepsilon_t = C^{-1}\varepsilon_t$
The term $\varepsilon_t$ is the combination of shocks.
Let

$$Y_t = \begin{bmatrix} x_t \\ y_t \\ z_t \end{bmatrix}, \; \Gamma_o = \begin{bmatrix} C_{10} \\ C_{20} \\ C_{30} \end{bmatrix}, \Gamma_1 = \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix} \text{ and } \varepsilon_t = \begin{bmatrix} \varepsilon_{xt} \\ \varepsilon_{yt} \\ \varepsilon_{zt} \end{bmatrix}$$

Then the matrix notation of the vector error can be put in form of

$$\begin{bmatrix} \varepsilon_{1t} \\ \varepsilon_{2t} \\ \varepsilon_{3t} \end{bmatrix} = \frac{1}{det(\alpha_1)} \sum_{i=0}^{\infty} \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}^{\iota} \times Adj(\alpha_1) \times \begin{bmatrix} \varepsilon_{1t-i} \\ \varepsilon_{2t-i} \\ \varepsilon_{3t-i} \end{bmatrix} \quad (20)$$

Simplifying the above representation obtained is defined with matrix $\theta$ is given as

$$\begin{bmatrix} x_t \\ y_t \\ z_t \end{bmatrix} = \begin{bmatrix} \bar{x} \\ \bar{y} \\ z \end{bmatrix} + \sum_{i=0}^{\infty} \begin{bmatrix} \theta_{11}(i) & \theta_{12}(i) & \theta_{13}(i) \\ \theta_{21}(i) & \theta_{22}(i) & \theta_{23}(i) \\ \theta_{31}(i) & \theta_{32}(i) & \theta_{33}(i) \end{bmatrix} \times \begin{bmatrix} \varepsilon_{xt-i} \\ \varepsilon_{yt-i} \\ \varepsilon_{zt-i} \end{bmatrix} \quad (21)$$

That contains element $\theta_{jk}(i)$, where

$$\theta_{jk}(i) = \frac{1}{det(\alpha_1)} \sum_{i=0}^{\infty} \begin{bmatrix} a_{11} & a_{12} & a_{13} \\ a_{21} & a_{22} & a_{23} \\ a_{31} & a_{32} & a_{33} \end{bmatrix}^{\iota} \times Adj(\alpha_1) \quad (22)$$

Equation (21) can be rewritten as

$$X_t = \mu_o + \sum_{i-0}^{\infty} \theta_{t-1} + \epsilon_t \quad (23)$$

The coefficients of $\theta_{jk}$ are the impulse response functions. The response of the shock can be visualized by the plot of the $\theta_{jk}$

## RESULTS AND DISCUSSION

**Empirical Analysis**
Table 1 and 2 below shows the descriptive statistics for making preliminary analysis of the data used. The variables are practically symmetrical and appear to be platykurtic with respect to the normal as all the kurtosis is less than three. The data distribution was not significantly different from normal as it was shown from Shakiro – Wilk test p value greater than 5. Also, the endogenous variable follows a normal distribution from Jarque – Bera test for normality

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**TABLE 1:** Descriptive Statistics

| VARIABLE | GDP | EXRATE | FDI | INF RATE | TRABAL |
|---|---|---|---|---|---|
| Mean | 173.899 | 91.7845 | 2.0013 | 0.1813 | 132.74 |
| Median | 73.4812 | 21.8952 | 0.78 | 0.1301 | 5813 |
| Maximum | 574.18 | 425.9792 | 8.84 | 0.7284 | 63700 |
| Minimum | 9.1809 | 0.5467 | -0.74 | 0.0346 | 180.7 |
| Std. Dev. | 175.912 | 115.8334 | 2.4391 | 0.1517 | 1581.33 |
| Sum | 9216.68 | 4864.583 | 106.07 | 9.6382 | 698155 |
| Sum Sq. Dev. | 1609155 | 697698 | 309.3632 | 1.1982 | 1.25E+10 |
| Shapiro Wilk Test | 0.9 | 0.9743 | 0.9326 | 0.9267 | 0.9466 |
| Observations | 53 | 53 | 53 | 53 | 53 |

**TABLE 2:** Test for Normality- Jarque Bera

| Variable | Test Stat. | P value (Chi^ 2) | Skewness | Kurtosis |
|---|---|---|---|---|
| GDP | 2.1297 | 0.4893 | 0.1931 | 0.1078 |
| EXCH RATE | 3.6920 | 0.2414 | -0.3250 | 0.7206 |
| FDI | 5.0387 | 0.2948 | -0.0468 | 1.0696 |
| INF RATE | 2.8561 | 0.6921 | 0.0102 | 0.3430 |
| TRADE BAL | 3.9746 | 0.5783 | -0.0658 | 0.8386 |

The results in Table 3 reveals non stationarity test of the times series using Augmented Dickey Fuller test for Unit Root which has the null hypothesis of unit root. the results indicated that ADF test reject the null hypothesis at 1%, 5%, and 10% of all the variables involved The series are not stationary in plain level but later become stationary at first difference Table 4 is the result of first difference. The series are stationary and the original series are first order cointegrated of degree 1, I(1). The optimal lag selection implemented the optimum endogenous lag search from information criteria using lag I to lag 10. The information criteria used are presented in Table 4. The information criteria with (*) in lag one was chosen using the selection criteria to determine the appropriate length.

**TABLE 3:** Augmented Dickey Fuller Test for Unit Root at plain level.

| Variable | ADF t-stat | 1% critical Value | 5%critical value | 10%critical value | Prob value | Conclusion |
|---|---|---|---|---|---|---|
| GDP | -0.3783 | -3.5653 | -2.9199 | -2.5971 | 0.9049 | Non-Stationary |
| EX-RATE | 2.8752 | -3.5683 | 2.91175 | -2.5955 | 1.0000 | Non- Stationary |
| FDI | -2.1406 | -3.5744 | -2.9237 | -2.5993 | 0.2303 | Non-Stationary |
| INF-RATE | -4.1362 | -3.5654 | -2.9199 | -2.5991 | 0.2024 | Non-Stationary |
| TRADE BAL | -2.1449 | -3.5626 | -2.9187 | -2.5929 | 0.2287 | Non-Stationary |

**TABLE 4:** Augmented Dickey Fuller Test for Unit Root at First Difference

| Variable | ADF t-stat | 1% critical Value | 5%critical value | 10%critical value | Prob value | Conclusion |
|---|---|---|---|---|---|---|
| GDP | -0.6917 | -5.2237 | -4.2271 | -1.8851 | 0.0000 | Stationary |
| EX-RATE | 0.3316 | -1.0843 | 0.0340 | -4.5930 | 0.0013 | Stationary |
| FDI | -4.1188 | -2.8539 | -2.1746 | -6.0416 | 0.0000 | Stationary |
| INF-RATE | -2.0454 | -3.0070 | -5.1084 | -0.0452 | 0.0000 | Stationary |
| TRADE BAL | -1.0210 | -2.5242 | -11.904 | -7.0031 | 0.0004 | Stationary |

**TABLE 5:** Optimal Lag Selection Criteria

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -1179.9 | NA | 6.94E+14 | 48.36335 | 48.5564 | 48.43659 |
| 1 | -957.538 | 390.2713* | 2.22e+11* | 40.3079* | 41.4694* | 40.7413* |
| 2 | -940.26 | 26.7991 | 3.14E+11 | 40.6284 | 42.7631 | 41.4248 |
| 3 | -922.304 | 24.1858 | 4.56E+11 | 40.9035 | 43.9903 | 42.0819 |
| 4 | -899.905 | 25.5988 | 6.02E+11 | 41.0651 | 45.0741 | 42.5455 |

*Minimum

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**Table 6:** Unrestricted Cointegration Rank Test (Trace)

| HypothesizedNo. of CE(s) | Eigenvalue | Trace Statistic | 0.05 critical value | Prob** |
|---|---|---|---|---|
| None * | 0.56101 | 94.0123 | 69.8188 | 0.0002 |
| At most 1 * | 0.3505 | 52.8483 | 47.8561 | 0.0158 |

**Table 7:** Unrestricted Cointegration Rank Test (Max- Eigen values)

| HypothesizedNo. of CE(s) | Eigenvalue | Max- Eigen Statistic | 0.05 Critical value | Prob** |
|---|---|---|---|---|
| None * | 0.5610 | 41.1643 | 33.8768 | 0.0057 |
| At most 1 | 0.3505 | 21.5837 | 27.5843 | 0.2425 |

*denotes rejection of the Hypothesis at 0.05 level
**Mackinnon-Huag-Michelis (1999) p-values.

Table 6 and 7 above shows the Johansen cointegration test. The trace statistics and the max Eigenvalues statistics indicate one cointegration equation at 0.05 significant level. The trace statistics and the maximum Eigenvalues are greater than the critical value at 0.05% which result in the rejection of the null hypothesis of no cointegration among the values.
The cointegration relation is expressed as an equation in equation (23)

$$Ect_{t-1} = 1.000GDP_{t-1} - 2.7410EXHRT_{t-1} + 6.2491FDI_{t-1} - 0.3167INF_{t-1} + 8.1366TRDBAL_{t-1} \quad (23)$$

Equation (23) can be simplified as follows:

$$GDP = +2.7410EXHRT_{t-1} - 6.2491FDI_{t-1} + 0.3167INF_{t-1} - 8.1366TRDBAL_{t-1} \quad (24)$$

Equation (24) reveals that 1% increase in Nigeria GDP will cause 2.75% increase in Exchange rate, 0.3167% increase of Inflation rate.6.249% decrease in FDI and 8.1366% decrease in Trade balance

**TABLE 8:** Pairwise Granger Causality Test

| Null Hypothesis: | F-Statistic | Prob. | Remark |
|---|---|---|---|
| EX-RATE does not Granger Cause GDP | 4.3135 | 0.0430 | Do not Reject |
| GDP does not Granger Cause EX-RATE | 1.3105 | 0.2579 | Reject Ho |
| FDI does not Granger Cause GDP | 7.5805 | 0.0083 | Do not Reject |
| GDP does not Granger Cause FDI | 0.2977 | 0.5878 | Reject Ho |
| INFLATION RATE does not Granger Cause GDP | 0.1330 | 0.7169 | Reject Ho |
| GDP does not Granger Cause INFLATION RATE | 0.8772 | 0.3535 | Reject Ho |
| TRADE BALANCE does not Granger Cause GDP | 17.387 | 0.0001 | Do not Reject |
| GDP does not Granger Cause TRADE BALANCE | 0.3448 | 0.5597 | Reject Ho |
| FDI does not Granger Cause EX-RATE | 0.8986 | 0.3478 | Reject Ho |
| EX-RATE does not Granger Cause FDI | 0.2458 | 0.6222 | Reject Ho |
| INFLATION RATE does not Granger Cause EX-RATE | 0.3151 | 0.5771 | Reject Ho |
| EX-RATE does not Granger Cause INFLATION RATE | 0.5101 | 0.4785 | Reject Ho |
| TRADE BALANCE does not Granger Cause EXRATE | 4.6047 | 0.0369 | Do not Reject |
| EX-RATE does not Granger Cause TRADE BALANCE | 4.3994 | 0.0411 | Do not Reject |
| INFLATION RATE does not Granger Cause FDI | 0.3430 | 0.5608 | Reject Ho |
| FDI does not Granger Cause INFLATION RATE | 0.6696 | 0.4171 | Reject Ho |
| TRADE BALANCE RATE does not Granger cause FDI | 0.1546 | 0.2083 | Reject Ho |
| FDI does not Granger Cause TRADE BALANCE | 12.142 | 0.0010 | Do not Reject |
| TRADE BALANCE does not Granger Cause INFLATION RATE | 1.2452 | 0.2699 | Reject Ho |
| INFLATION RATE does not Granger Cause TRADE BALANCE | 0.0311 | 0.8608 | Reject Ho |

Table 8 above is the results of causality test among the variables. The results of the causality direction are determined using Pairwise Granger Causality test. Moreover, there is bidirectional causality between inflation and GDP, Inflation and FDI, inflation and Trade Balance, Inflation and exchange rate and FDI and Exchange rate whereas there is a unidirectional causality between GDP and Exchange rate, GDP and Trade Balance and Trade balance and FDI but no causality was found between Trade balance and Inflation rate. The result revealed that the micro economic variables under study can help in forecasting the economic growth in Nigeria

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**Table 9:** VECM (1) Estimates

| Error Correction | D(GDP) | D(EX-RATE) | D(FDI) | D(INFL RATE) | D(TR BAL} |
|---|---|---|---|---|---|
| COINTEq1 | -0.2566 | -0.0328 | -0.0586 | -0.0356 | 2.8103 |
| | {-0.054} | {-0.030} | {-0.0021} | {-0.0002} | {-1.450} |
| D(GDP (-1)) | 0.2957 | 0.05221 | -0.0013 | -0.0007 | -10.0093 |
| | [-0.1565] | [-0.087] | [-0.0061] | [-0.027] | [-4.155] |
| D(EX-RATE (-1)) | 0.1597 | 0.4429 | -0.0187 | -0.0394 | 3.5971 |
| | [-0.2817] | [-0.1575] | [-0.0110] | [-0.0014] | [-0.239] |
| D(FDI (-1)) | -0.1276 | 1.4244 | -0.3176 | 0.0777 | 5.3048 |
| | [-3.9361] | [-2.2016] | [-0.1547] | [-0.0196] | [-10.348] |
| D(INFLATION RATE(-1)) | 0.2279 | 0.0538 | 1.3267 | 0.0477 | 5.7531 |
| | [-30.496] | [-17.057] | [-1.1989] | [-0.1523] | [-18.0432] |
| D(TRADE BALANCE(-1)) | -0.1893 | -0.0347 | 1.0600 | -2.4542 | -0.1917 |
| | [-0.0005] | [-0.0003] | [-2.3008] | [-2.9000] | [-0.1871] |
| C | 5.2565 | 4.2776 | 0.1413 | 0.0134 | -1.1771 |
| | [-5.2651] | [-2.945] | [-0.2070] | [-0.0262] | [-6.4505] |
| R-squared | 0.9244 | 0.5677 | 0.7824 | 0.5231 | 0.6169 |
| S.E. equation | 2.0207 | 1.2321 | 1.1461 | 0.1493 | 0.1582 |
| Akaike AIC | -0.0074 | -0.5383 | 0.0292 | -0.8926 | -1.2393 |
| Schwarz SC | 9.9893 | 8.8035 | 3.4935 | -0.6318 | 11.5049 |

Table 9 gives the results of VEC model utilized to ascertain the long run causal relationship amongst variables. The Akaike information criteria values of the VECM model are relatively small with $R^2 > 0.5$ indicates the logical justification of the model estimation. The short run equilibrium is corrected towards the long run equilibrium at the speed of about 26% which is statistically significant. The speed of adjustment is indicated by the coefficients of the error correction term, the negative value of error correction coefficient shows that GDP in Nigeria with determinant variables converge to long run equilibrium, the results also established a long run and short run causality among the variables.

**VECM ESTIMATE MODEL**

$$\begin{pmatrix} \Delta GDP_t \\ \Delta EXCRT_t \\ \Delta FDI_t \\ \Delta INFRT_t \\ \Delta TRD\ BAL_t \end{pmatrix} = \begin{pmatrix} 5.2565 \\ 4.2776 \\ 0.1431 \\ 0.0138 \\ -1.1771 \end{pmatrix} + \begin{pmatrix} 0.2957 & 0.0522 & 0.0014 & -0.008 & -20.009 \\ 0.1597 & 0.4425 & -0.0187 & -0.0394 & 18.597 \\ -0.1276 & 1.424 & -0.3175 & 0.0775 & 15.304 \\ 0.2279 & 0.0538 & 1.326 & 0.0470 & 45.753 \\ -0.1893 & -0.0347 & 1.0600 & -2.4504 & -0.1091 \end{pmatrix} \begin{pmatrix} \Delta GDP_{t-1} \\ \Delta EXRT_{t-1} \\ \Delta FDI_{t-1} \\ \Delta INFRT_{t-1} \\ \Delta TRDBAL_{t-1} \end{pmatrix} \quad (25)$$

The estimated VECM equation as GDP as a target variable is

$$\Delta GDP = -0.2566\,ECT + 0.2957GDP_{t-1} + 0.1597EXRT_{t-1} - 0.1276FDI_{t-1} + 0.2279INFRT_{t-1} - 0.1893TRDBAL_{t-1} + 5.2565$$

(26)

The present GDP has a relationship of 16 and 23 percent increase in exchange rate and inflation respectively while a 1% increase in GDP is followed by12 and 19 percent reduction in FDI and Trade Balance respectively.

**VEC Model Adequacy**

Checking of Model adequacy is very essential in VECM estimation to achieve an efficient and unbiased model. The AR Roots test for stability are presented in table 10 and figure 1 while the diagnostic checking of serial correlation, heteroskedacity and normality are presented in Table 11. The residual graph presented in figure 2 shows the normality of the VEC model.

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**Table 10:** VECM Eigenvalue Stability Condition

| Eigenvalue | Modulus |
|---|---|
| 1 | 1 |
| 1 | 1 |
| 1 | 1 |
| 1 | 1 |
| 0.612863 | 0.612863 |
| 0.218957 - 0.074261i | 0.231208 |
| 0.218957+ 0.074261i | 0.231208 |
| -0.118222- 0.182279i | 0.217261 |
| -0.118222 + 0.182279i | 0.217261 |
| -0.162945 | 0.162945 |

Remark: All the eigenvalues lie inside unit root which satisfies stability condition

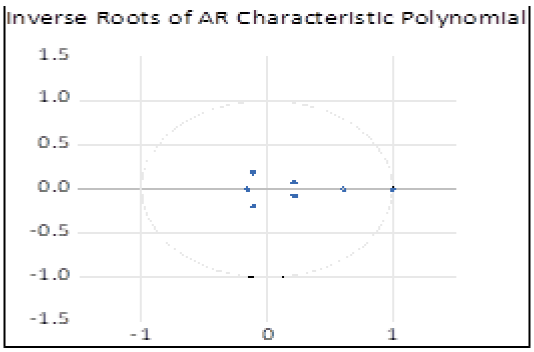


**Figure. 1:** Stability graph of VEC Model

The AR Roots graph display the inverse roots of characteristic AR polynomial. The VAR is stable since we have all the roots lie inside unit root circle otherwise there will be no valid results of impulse response standard errors. The stability of the VAR model implies that the sequence of GDP, exchange rate, FDI, inflation and Trade Balance have a finite and time invariant mean and variance.

**Table 11:** VECM model Diagnostic Checking

| Test | Null Hypothesis | t-statistic | p- value | Remark |
|---|---|---|---|---|
| Jarque- Bera | Residual are normally distributed | 0.2429 | 0.6187 | Residuals are normally distributed |
| Breusch Godfrey LM | No serial correlation | 0.3367 | 0.8763 | No serial correlation in the model |
| White's test for heteroskedacity | No heteroskedacity | 0.2261 | 0.7421 | No heteroskedacity |

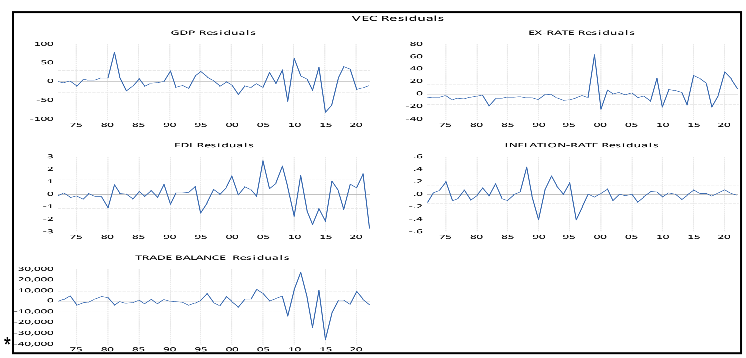


**Figure. 2:** VECM Residual

**The Impulse Response Function Analysis**

The focus of the work is majorly on the determinants and stability of Nigeria economic growth, figure 3 shows the diagrammatic representation of the impulse response function (IRF) of the dynamic response of Nigeria GDP to a one period standard deviation shock to the innovations of the model indicating the directions and persistency of the GDP to each of the shocks over a period of 10 years. Figure 2 reported shocks of two variables that not significant from zero and transitory in nature while the shock to the remaining variables is significant with only one that is persistent.

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A one period standard deviation shock to inflation marginally appreciates GDP yet the influence on average diminishes quickly. Moreover, the response of GDP to a one period shock to the trade balance yields a marginal negative depreciation justifying the result of Ezeaku *et al.,* 2018 while the shock to the Exchange rate produced a persistent positive effect on the GDP establishing the outcome of Anochie *et al*., (2023) research. The shock on foreign direct investment on GDP marginally falls into a transitory depreciation and thus the significant influence of the Trade balance and the exchange rate on the GDP is in the short run.

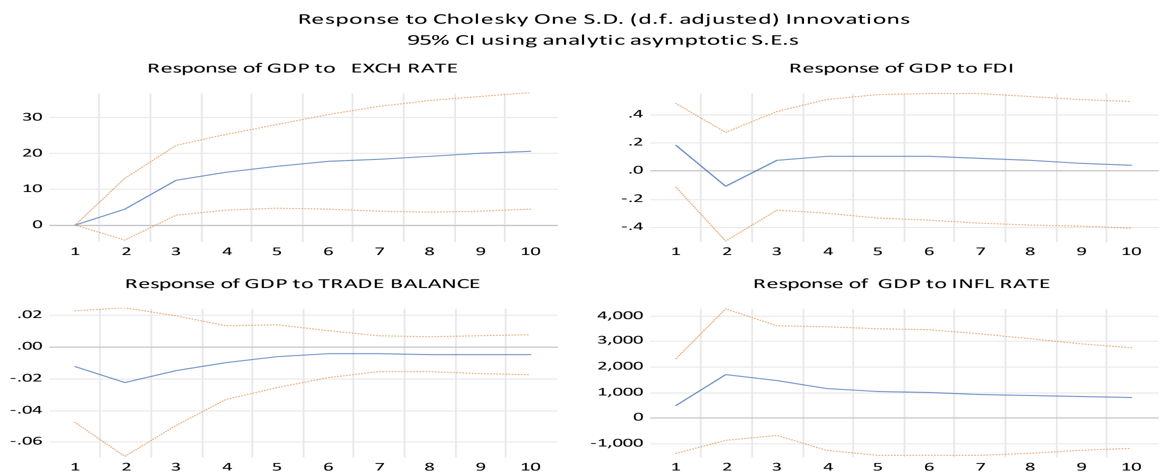


**Figure 3:** Impulse Response Functions of GDP to other macroeconomic variables**.**

**Table 12**: Forecast Error Variance Decomposition of GDP

| Period | S.E. | GDP | EXRATE | FDI | INF RATE | TRD BAL |
|---|---|---|---|---|---|---|
| 1 | 29.0202 | 100.0000 | 0.0000 | 0.0000 | 0.0000 | 0.0000 |
| 2 | 43.8890 | 88.5607 | 0.5720 | 0.3138 | 0.6404 | 9.9161 |
| 3 | 60.7136 | 77.9319 | 5.3145 | 1.7864 | 2.6745 | 22.3716 |
| 4 | 77.5826 | 73.8978 | 10.3140 | 3.2883 | 3.4699 | 29.1029 |
| 5 | 93.3892 | 74.7446 | 14.4466 | 4.3613 | 3.8566 | 32.6518 |
| 6 | 108.1302 | 68.6422 | 17.5799 | 5.0361 | 4.0868 | 34.6303 |
| 7 | 121.7982 | 64.4278 | 19.9259 | 5.5867 | 15.2941 | 35.8342 |
| 8 | 134.4883 | 61.4057 | 21.6938 | 5.9647 | 24.3248 | 36.6129 |
| 9 | 146.3155 | 59.1649 | 23.0487 | 6.2436 | 24.3922 | 37.1501 |
| 10 | 157.3923 | 57.4544 | 67.5408 | 7.5478 | 54.5408 | 49.5478 |

Table 12 above showed the forecast error variance decomposition for GDP, the 100% forecast error variance of the GDP is explained by GDP itself in the short run which run into the future. The long run horizon 10 revealed that the proportion of the forecast error in GDP recorded by exchange rate is 67% and 54% by inflation while 50% proportion was recorded by Trade balance. The proportion of the forecast error of GDP influencing the FDI is weakly significant while the inflation is weak in the short run but strong at long run horizon. The result justifies that the place of Exchange rate, Inflation and Trade Balance to Nigeria economic growth cannot be overstated.

**Summary and Conclusion**

Economic growth is the top priority of macroeconomic coverage in any country The influence of macroeconomic variables on the financial boom of Nigeria is investigated in this work through the consideration of GDP growth (GDP) as the representative of economic growth.

The study analyzed the causal interrelationship among selected economic indicators in Nigeria using VECM and impulse response functions. VECM method of estimations was administered to evaluate the presence of short run and long run relationship between Nigeria economic growth and exchange rate, foreign direct Investment, Inflation rate and the Trade balance. The Granger causality test was used to examine the direction of the causality among the variables, the series are stationary at I(1) and are co-integrated which activate the implementation of VECM. Cointegration estimation revealed the nature of interrelation within the variables. The causality direction was more announced with the aid of VECM and relative Endogeneity of the variables were bring into view with the results of Impulse Response Functions and Forecast Error Variance Decomposition

From the results of the study, the presence of long run co-integrations between the economic growth in Nigeria and the

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selected variables shows that to promote stable and viable economic growth, policy makers should lay more emphasis on encouraging stable and reasonable exchange rate. Also, Anti-inflationary policies should be accompanied to attract foreign investors and frustrate capital fleeing from the country.

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