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Modeling the Effects of Foreign Direct Investment, Exchange Rate and Inflation on Economic Growth in Nigeria: Auto Regressive Distributed Lag Approach

[1]✉Adewole A.I., [2]Amurawaye F.F. and [3]Fasanmade I.O.

[1&2]Department of Mathematics, Tai Solarin University of Education
Corresponding Author: amurawayeff@tasued.edu.ng
Other Authors: adewoleai@tasued.edu.ng, fasonmade@gmail.com

Abstract

This study examined the economic impact of foreign direct investment, exchange rate of Naira to dollar and inflation rate on Nigeria economic growth using RGDP as proxy. A linear dynamical Autoregressive Distributed Lag (ARDL) modeling technique was utilized to evaluate the short-run dynamics and long-run relationship of economic growth in Nigeria. The study covered the period from 1970 to 2023, and annual secondary data were obtained from the Central Bank of Nigeria (CBN) statistical bulletin. The result ascertained a distinctive long-run relationship among the variables which revealed that there is a significant relationship between foreign direct investment, exchange rate, inflation rate and economic growth in Nigeria. Also, it was shown from the empirical result that inflation rate and the exchange rate have positive and insignificant influence on real gross domestic product in Nigeria in the long-run while foreign direct investment revealed an irrelevant consequence on Nigeria economic growth in the long run. The findings ascertain the significance of FDI, exchange rate, and inflation contributions to Nigeria economic growth. This work therefore recommends that policy makers should erect a suitable policy that encourages moderate inflation rate and enabling environment for foreign investors that would enhance exports thereby yield a stable and realistic exchange rate.

Keywords: ARDL, Economic growth, Macroeconomic variables, Stationarity

INTRODUCTION

Economic growth can be termed as a continuous development in a country's ability to meet the demand of consumer for products and services as a result of higher productivity in volumes. Olorogun *et al.*, (2022), Caliskan, (2015) described economic growth as steady rise transpiring in the production and consumption of goods and services within an economy. Economic growth revealed the growth that occur in the productive potential of an economy Nigeria, being one of the most populous countries in Africa, holds considerable significance in the global economy. Understanding the factors influencing its growth is imperative, given its historical instability (Abdulkarim, 2023; Anyanwu, 2014). Economic challenges and opportunities have been pivotal in shaping Nigeria's economic trajectory. Instabilities in key macroeconomic indicators have further exacerbated uncertainty, hindering improvement regarding sustainable long-term progress objectives.

RELATED WORKS

Numerous studies (Adewole et al., 2018, 2020, 2023; Ojobo, 2021; Al-Masbhi and Du, 2021; Bodunwa et al., 2022; Anochie et al., 2023) have explored the topic, revealing inconsistent findings likely stemming from variations in econometric methodologies, data sources, and coverage. Consequently, further investigation is warranted to analyze the determinants of economic advancement in Nigeria. This study utilizes Autoregressive Distributed Lag (ARDL) modeling tools to estimate and analyse the empirical relationship among Nigeria's Foreign Direct Investment (FDI), exchange rate, inflation rate, and Real

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Gross Domestic Product (RGDP). These variables are pivotal in shaping the country's overall economic performance.

Foreign direct investment (FDI), currency rates and the inflation rates are significant facets of the economic environment (Kamal *et al*,.(2021). Foreign direct investment (FDI) is one of the major elements in developing the economic growth of any nation across the globe. FDI is an important variable in the world economic integration offering financial stability that results in economic growth of a nation. FDI is essential for capital formation regarding the necessity of its inflow and outflow for economic growth (Gochero and Boopen (2020). FDI generalize the practice of bringing foreign capital into a country with the aim of creating goods for domestic use and export. Exchange rates play a crucial role in establishing the worth of a domestic currency compared to foreign currencies, thus influencing international trade and competitiveness. They serve as essential economic indicators for evaluating overall economic performance (Benedict and Bismark, 2022). The precise determination of exchange rates governs the relative prices of domestic and foreign goods, impacting the strength of the external sector's contribution to international trade. Meanwhile, inflation rate refers to the continuous increase in the general price level within an economy over time. It measures the stability of macro -economic conditions of a nation. Consumer price index is one of the major tools used in determining the gauging level of inflation in an economy (Ugwu *et al*., 2018). Moreover, inflation can be generalized as the aggregate and continuous rise that occur in the price level of commodities in an economy (Chishiti *et al*., 2021).

Real GDP gives an accurate measurement of actual economic growth because it accounts for inflation. Research on economic growth, spanning theoretical and empirical study, takes various forms in exploring the relationship between economic growth and macroeconomic variables. For example, Abubakar et al. (2023) investigated the influence of governance quality on the dynamic interconnection among foreign direct investment, trade openness, and economic growth in Nigeria, utilizing the ARDL model. Their findings suggest that the interplay between foreign direct investment and governance quality did not demonstrate a contagious effect on the economy. Additionally, their investigation concluded that foreign exchange had little to no significant impact on the Nigerian economy. Rehman *et al*. (2021) investigated the coexistence of the relationship between nominal exchange rate volatility and dollarization in Nigeria using the Granger causality test for the period from 1986 to 2003. Their findings demonstrated causality among the variables, with dollarization exerting a stronger and dominant causal influence on exchange rate volatility. The influence of the above-mentioned macroeconomic variables on Nigeria's economic growth remains unsettled, as there is no harmony in the literature concerning their short-term and long-term effects.

Usmana and Osagie (2023) utilized ARDL with Vector Error Correction (VEC) Models to estimate the long-term and short-term effects of key macroeconomic variables on Nigeria Gross Domestic Product (GDP). Their research revealed that, according to the ARDL model, the Exchange Rate and interest rate were positively related to Gross Domestic Product (GDP) but statistically insignificant.

This research endeavors to reexamine the statistical investigation of the relationship amongst significant economic variables and economic advancement in Nigeria, offering constructive insights for stakeholder and policy officials through the usage of ARDL modeling techniques.

MATERIAL AND METHODS

Description of Data

The data for this work consists of secondary data sourced from the Central Bank of Nigeria (CBN) statistical communiqué. It encompasses an annual dataset spanning from 1970 to 2023, obtained from the Nigeria CBN bulletin, featuring figures of Real Gross Domestic Product (RGDP) per capita, rate of Inflation, and Exchange rate of Naira against US Dollar

Model Specification.

Autoregressive distributed lag (ARDL) model

The study utilizes the ARDL estimation technique to examine the short-term and long-term impacts of foreign direct investment, exchange rate, and inflation on economic advancement in Nigeria. Economic growth, as estimated by the rate of real GDP development. The ARDL model encompasses both endogenous and exogenous variables. This modeling approach enables the endogenous variable to be clarified by the endogenous variables along with their lags, and also by its own lag.

Considering the general ARDL(p,q) model as follows

$$y_t = \gamma + \sum_{t=1}^{p} \theta_i y_{t-i} + \sum_{t=0}^{q} \emptyset_i X_{t-i} + \varepsilon_t \quad (1)$$

Equation (1) can be simplified as below;

$$y_t = \gamma + \theta_1 y_{t-1} + \theta_2 y_{t-1} +, \dots, \theta_p y_{t-p} + \emptyset_1 X_{t-1} + \emptyset_2 X_{t-1} +, \dots, + \emptyset_q X_{t-q} + \varepsilon_t \quad (2)$$

where

y_t is the exogenous variable

y_{t-1} refers to the previous values of the exogenous variable

X_t is the endogenous variable

X_{t-i} refers to the previous values of the endogenous variable

p, represents the optimum Lag order corresponding to the exogenous variable

q represents the optimum Lag order corresponding to the endogenous variable

γ denotes the constant estimate,

θ_i is the short run coefficient for dependent variable

$\emptyset_i$ is the long run coefficient for independent variable

ε_t denotes the error term.

The linear relationship among the variables under study in accordance to equation (3) above can be expressed as;

$$\text{Ln}(RGDP) = \gamma + \emptyset_1 ln(FDI) + \emptyset_2 ln(EXC\ RT) + \emptyset_3 ln(INF\ RT) + \varepsilon_t \quad (4)$$

From the above equation, RGDP is the real gross domestic product; FDI is the foreign direct investment; EXC RT is the exchange rate, INF RT is the inflation rate and ε_t represents the white noise error term. The macroeconomic variables under study in Nigeria are in their natural log form.

Estimation and Preliminary Tests

To ensure a reliably specified model, conducting preliminary tests on the variables is crucial. In this study, pre-estimation tests include stationarity tests using Augmented Dickey-Fuller and Phillips-Perron tests, co-integration tests with the ARDL Bounds test, and the determination of the optimum lag length.

Stationarity Test.

The ARDL method offers the advantage of analyzing time-series data without requiring uniform integration orders, as long as none of the variables are integration of second order. It is applicable to underlying regressors with integration orders of one I(1), zero I(0), or fractional integration. The stationary properties of the variables were assessed using the Augmented Dickey-Fuller (ADF) test and confirmed using the Phillips-Perron (PP) test and Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test

Augmented Dickey-Fuller Test

The Augmented Dickey-Fuller (ADF) test is of unit root. The test is expressed in the following form;

$$\Delta y_t = \alpha_0 + \beta_1 t + \gamma y_{t-j} + \sum_{j=1}^{k} \mu_j \Delta y_{t-j} + \epsilon_t \quad (5)$$

t is equivalent to n+1……T

and α represent constant value while β denotes the coefficient of time trend and $\sum_{j=1}^{k} \mu_j \Delta Y_{t-j}$ represent the summation of the lagged *Y*s along with their coefficients.

Kwiatkowski-Philips-Schmidt-Shin(KPSS) Test

The null hypothesis assumes that the Data Generating Process (DGP) is stationary. Considering the following DGP without a linear trend;

$$y_t = x_t + z_t \quad (6)$$

where

$$x_t = \alpha_1 x_{t-1} + \alpha_2 x_{t-2} +, \dots, \alpha_p x_{t-p} + u_t \quad (7)$$

$u_t \sim iid(0.\sigma^2)$ and z_t is assume to follow a stationary process.

KPSS test statistic is expressed as;

$$KPSS = \frac{1}{N^2} \sum_{n=1}^{N} \frac{s_t^2}{\sigma^2 \infty} \quad (8)$$

Where $s_t = \sum_{j=1}^{t} \hat{m}_j$ with $\hat{m}_t = x_t - x$ and $\hat{\sigma}_\infty{}^2$ is an estimator of the long run variance of the stationary Process z_t.

Co-integration – ARDL-Bounds Testing Approach

The Autoregressive Distributed Lag (ARDL) Bounds testing approach is used to explore the long-term relationship between FDI, exchange rates, inflation rates, and economic growth.

Considering the conditional ARDL (p, $q_1, q_2, \dots, q_k$) model with k variables with the hypothesis;

$H_0: b_{jk} = 0$

$H_0: b_{jk} \neq 0$

where j, k = 1, 2,…,k

If co-integration is absent, the ARDL(p, q_1, q_2, q_3) model for this study is specified in equation (9) below.

$$\Delta RGDP = \beta_i + \sum_{i=1}^{p} \beta_{1i} \Delta lnRGDP_{t-1} + \sum_{i=0}^{q_1} \beta_{2i} \Delta lnFDI_{t-1} + \sum_{i=0}^{q_2} \beta_{3i} \Delta lnEXCH\ RT_{t-1} + \sum_{i=0}^{q_3} \beta_{4i} \Delta lnINF\ RT_{t-1} + \varepsilon_t \quad (9)$$

Whereas, when there is cointegration among the variables, the specification of error correction model (ECM) representation is expressed as;

$$\Delta RGDP = \beta_0 + \sum_{i=1}^{p} \beta_{1i} \Delta lnRGDP_{t-1} + \sum_{i=0}^{q_1} \beta_{2i} \Delta lnFDI_{t-1} + \sum_{i=0}^{q_2} \beta_{3i} \Delta lnEXCH\ RT_{t-1} + \sum_{i=0}^{q_3} \beta_{4i} \Delta lnINF\ RT_{t-1} + \psi ECT_{t-1}\ \varepsilon_t \quad (10)$$

where ψ is the speed of adjustment, ECT is the error correction term, β_0 is the constant, $\beta_{1i}, \beta_{2i}, \beta_{3i}, \beta_{4i}$ represent the short run dynamic coefficient of the model's adjustment long-run equilibrium. The significant of ψ captured the causal effect long run relationship while Δ is the difference operator that captures the short-run effect.

Selection of optimum lag length: The lag length for the variables is decided using selection criteria such as the minimum values of Akaike's Information Criterion (AIC), Schwarz Bayesian Criterion (SBC), and Hannan-Quinn Criterion (HQC). The selection criteria values for the general ARDL (p, $q_1, q_2, \dots, q_k$) model are provided by the following expression**;**

$$AIC_n = (1 + log2\pi) - \frac{m}{2}\ log\gamma^2 - N \quad (11)$$

$$SBC_n = log\gamma^2 + \left(\frac{logm}{m}\right) N \quad (12)$$

$$HQC = log\gamma + \left(2 \log \frac{logm}{m}\right) N \quad (13)$$

According to Nkoro and Uko (2016), γ signifies the maximum likelihood estimator of regression error variance, m represents the amount of estimated parameters, and n =1, 2,.., N,where N denotes the optimal order of the selected model.

Model Robustness Check

To validate the adequacy of the selected ARDL model, the normality, serial correlation, and heteroscedasticity tests were conducted using the Jarque-Bera (JB) test for normality, the Breusch-Godfrey test for serial correlation, and the Breusch-Pagan-Godfrey test for heteroscedasticity.

Parameter Stability Test (CUSUM Graph)

The Cumulative Sum (CUSUM) test is used to assess stability of the estimated parameters of the regression model.. It examines the null hypothesis H_0: the parameters are steady, against alternative hypothesis H_1: the parameters are not stable.

RESULT AND DISCUSSIONS

Table 1. Descriptive Statistics

Variable	Ln RGDP	Ln FDI	Ln EXCHRATE	Ln INF RATE
Mean	173.899	2.0013	91.7845	0.1813
Median	73.4812	0.78	21.8952	0.1301
Max.	574.18	8.84	425.9792	0.7284
Min.	9.1800	0.69	0.5467	0.0350
Standard Dev.	175.912	2.4391	115.8334	0.1517
Sum	9216.68	106.07	4864.583	9.6382
Sum Sq. Dev.	1609155	309.3632	697698	1.1982
Skewness	0.7257	0.0156	0.0388	0.5965
Kurtosis	3.47137	2.2390	2.842877	3.4713
Shapiro Test	0.89	0.9230	0.9743	0.9210
Observations	53	53	53	53

The descriptive statistics of the variables and aggregate averages such as mean, median, the measures of spread and variation are presented in Table 1. The variables are symmetrical and leptokurtic with respect to the normal distribution.

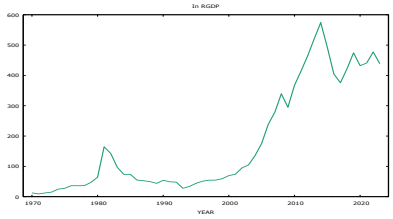

Figure 1. Time plot of RGDP

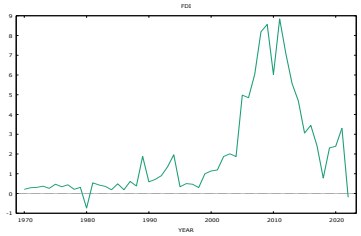

Figure 2. Time plot of FDI

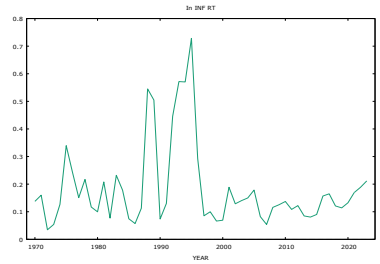

Figure 3. Time plot of Inflation rate

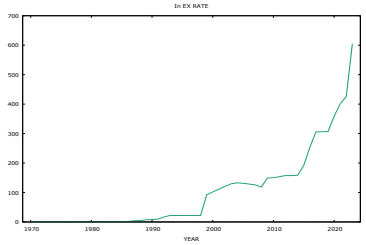

Figure 4. Time plot of Exchange rate

Figures 1 to 4 present the natural log transformations of macroeconomic variables employed in this work. The exchange rate graph shows a rapid increase, while RGDP increases slowly and remains stable. In contrast, FDI and inflation exhibit fluctuations. All variables are expressed as percentages of the US dollars.

Table 2. ADF. Test for Stationarity.

	Level				First Difference				
Variables	**ADF. t-stat**	**Philip P. t- stat.**	**KPSS t- stat**	**Conc.**	**Variables**	**ADF. t-stat**	**Philp P. t- stat.**	**KPSS t- stat**	**Conc.**
RGDP	-0.2437	0.2456	0.2191	N. stationary	RGDP	-2.1659	-0.3490	0.0516	Stationary
EXRT.	0.8387	0.5656	0.1791	N. stationary	EXRT.	-0.2959	-1.6393	0.0910	Stationary
FDI	-2.6114	-2.3657	0.2592	N. stationary	FDI	-2.7259	-0.2923	0.0136	Stationary
INF-RT	-1.3713	-2.2856	0.1091	N. stationary	INFRT	-219.59	-0.7504	0.0503	Stationary

The stationarity test results in Table 2 indicate that none of the variables were stationary at their levels. However, after taking the first difference, all four variables became stationary at the 5% critical level, indicating that the variables are integrated at I (1).

Table 3. Best Selection Criteria

Lag	**AIC**	**SIC**	**HIQ**	**ARDL: Model**
1	43.2130*	42.6246*	42.1173*	1,1,1,0
2	44.2562	43.4576	44.2448	1,2,1,0
3	45.2935	45.0993	45.6819	1,2,2,0

Table 3 above presents the optimal lag length selection along with their corresponding information criteria: - Akaike Information Criterion (AIC), Schwarz Criterion (SC), and Hannan-Quinn Criterion (HQIC). The table also includes the selected ARDL models. The information criterion with an asterisk (*) at lag one was chosen based on the minimum value.

Table 4. ARDL Bound test for Co-integration

Null Hypothesis: No Long- run Relationship exist		
Test Stat.	**Value**	**K**
F Stat.	7.14520	3
Critical values bound		
Sign.	I(0)	I(1)
10%	2.7429	3.2489
5%	2.8238	3.4296
2.5%	3.1929	3.9357
1%	4.1995	4.6644

ARDL Bound test for co-integration examined the relationships among the variables by comparing the value of F-statistic to the upper and lower critical bound values. Table 4 shows a clear long-run association among the variables, as the F-statistic exceeds both the upper critical bounds and lower. This indicates a rejection of the null hypothesis, which posits no long-run relationship. The results suggest a significant relationship between foreign direct investment, exchange rate, inflation rate, and economic growth in Nigeria.

Table 5. ARDL model Result

Regressor	**Coefficient**	**Standard error**	**t- statistics**	**Probability**
C	0.62743	0.28533	2.78276	0.0004
LNRGDP(-1)	-0.17813	0.02876	-1.29717	0.0000
LN FDI (-1)	-0.02212	0.04862	0.38158	0.2294
LN EXCH RT(-1)	0.18153	0.08251	0.27417	0.0002
LN INF RT(-1)	0.37367	0.19022	0.38960	0.0212
D(LN INF RT)	0.06213	0.09410	-0.35057	0.2251

D(LN EXCH RT)	-0.03611	0.01621	0.02871	0.1924
LN FDI	0.21826	0.16075	0.32634	0.0001
LN EXCH RT	0.62430	0.04186	0.52933	0.0000
LN INF RT	0.31277	0.11188	0.76471	0.2501
R^2 $Adj -$ 0.9834, F Statistics - 384.1350, Prob (F statistics) - 0.0000				

Table 5 presents the results of the ARDL model, including estimates of both short-run and long-run coefficients of FDI, exchange rate, and inflation rate. The findings indicate inflation rate coefficient is 0.06213, having probability of 0.2251 suggesting a positive yet irrelevant effect on real gross domestic product, even in the short term. Similarly, the rate of exchange is -0.03611 with an associated probability of 0.1924, indicating a negative and insignificant influence on Nigeria RGDP particularly in the short term. Moreover, the positive values of inflation and exchange rate imply that they have positive yet insignificant impacts on Nigeria RGDP in the long term, while the negative coefficient of foreign direct investment reveals an unimportant influence on Nigeria's economic growth in the long run. The adjusted R-squared value of 98.35% reveals a substantial proportion of the variation in real gross domestic product accounted for by variations in FDI, exchange rate, and inflation rate. The significance and adequacy of the ARDL model is validated by the F-statistic value of 384.1350 having the probability of 0.0000.

Model Diagnostics

Table 6. Statistical tests of the residuals

Test	H_0	T-stat.	Prob.	Conc.
Jarque- Bera test.	Normally distributed Residual	0.3624	0.3761	Normally distributed residual
Breusch Godfrey LM test.	Absence of serial correlation	0.2933	0.4087	Absence of serial correlation
Breusch-Pagan-Godfrey test,	Homoskedacity	0.4122	0.5274	Homoskedacity

Table 6 gives the result of the normality, autocorrelation and Heteroskedacity check and the respective p values for the selected ARDL model. The normality tests revealed that the residuals generated are normally distributed, Breusch Godfrey LM test revealed absence of autocorrelation among the residual of the model. More so, the results of heteroscedasticity tests of residuals revealed homoscedasticity nature of the residuals.

Stability Test (CUSUM Graph)

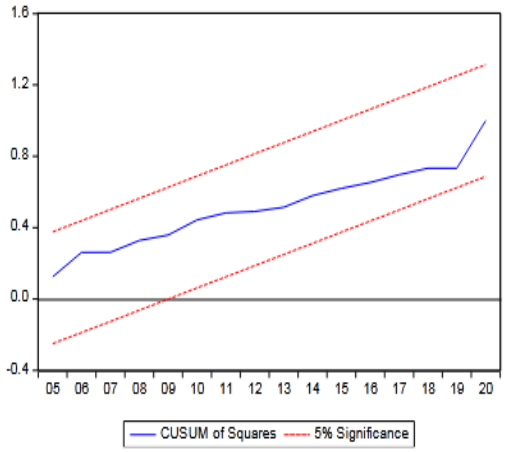

Figure 5. CUSUM of Squares Stability Test

The recursion residual test for fundamental stability's CUSUM of Squares is used to assess the reliability of the regression coefficients. Given that the CUSUM of Squares tests statistics did not surpass the 5% level of significance boundary, CUSUM of Square plots indicate that the regression equation appears stable.

CONCLUSION

The study investigated the influence of foreign direct investment (FDI) Exchange rate of Naira to dollar and inflation rate (INFR), on RGDP as representation for Nigeria economic performance ranging from the period of 1980 – 2013 (53 years) with an ARDL model. The findings from the work revealed the existence of a distinctive long-run relationship among the variables which implies a significant relationship among the FDI, exchange rate, inflation rate and economic development in Nigeria.

The model was found to be stable, absence of heteroskedacity and serial correlation in the residual of the model. Additionally, the results of the CUSUMQ tests showed that they are within the critical limits.

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