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INVESTIGATION OF SHORT-TERM AND LONG-TERM EFFECTS OF MACROECONOMIC VARIABLES ON GROSS DOMESTIC PRODUCT IN NIGERIA USING THE AUTOREGRESSIVE DISTRIBUTED LAG APPROACH

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ABSTRACT
The investigation of the relationship between exchange rate volatility and other macroeconomic factors raises concerns for Nigeria's economy today, given the role of the exchange rate. The Autoregressive Distribution Lag (ARDL) model was employed to analyse the interest rate, inflation rate, economic growth, and trade balance of the macroeconomic variables and to identify their effect on Nigeria's economic growth. Additionally, the mean and variance patterns in exchange rate volatility were captured for effective examination of how shocks and policy changes affect GDP over time. The study revealed that some of the variables have a considerable short-term and long-term impact on the growth of the economy particularly, coefficient of -0.0106 and p-value of 0.0048 for GDP implies a negative effect of past GDP on current GDP, inflation with coefficient of 0.0006 and p-value of 0.7023 showed a positive but insignificant effect on GDP, interest rate coefficient of -0.0364 and p-value of 0.0004 suggested a negative impact on GDP, exchange rate with a coefficient of 0.0168 and p-value of 0.0778 was positively associated with economic growth, and trade balance with a coefficient of 0.0052 and p-value of 0.0424, showed a positive, significant short-term effect on GDP. In conclusion, this work provided empirical facts and guidance for the stakeholders for effective planning, and recommends that monetary and fiscal policies should be given attention.

Keywords: Autoregressive Distributed Lag (ARDL) Model, Gross Domestic Product, Inflation rate, Interest rate, and Trade Balance

INTRODUCTION

The consistent inflation of the Nigeria economics had deeply slow down the economic growth of the country. In fact, one percent of increase in GDP lead to decline in unemployment rate with about -0.019 Karimo (2020), Using Autoregressive Distributed Lag (ARDL) model in measuring the effect of inflation and unemployment on economic growths, show an inversely correlation of the unemployment while the inflation indicated to have a positive relationship (Nanchi & Ugochukwu, 2023). The long and short run impact of energy consumption of oil prices was probed for a group of African countries that are included in OPEC, using Autoregressive Distributed Lags (ARDL) and unrestricted Error Correction Model (ECM) approach for the period 1973 to 2017, and notably, the long run shows the positive impact of urban over GDP in just two countries, while all others are negative among the six (6) OPEC countries (Victor and Mara, 2020).

Agu *et al*, (2022) anticipated gross domestic products to macroeconomic indicators using fivefold cross validation with the aim of identifying key macro-economic variables that affect the growth of GDP. Their study revealed PCR method had an accuracy of 89% and a mean square error of -7.552007365635066e and predicted GDP to macroeconomic indicators accurately better than other methods, additionally, they were able to discovered the machine learning regularization form of predicting GDP instead of our usual traditional statistic methods. The investigation of inflation on economic growth of Nigeria was examined using the Autoregressive Distributed Lag (ARDL) model on the selected variables such as GDP, inflation, interest rate, money supply and government consumption expenditure for thirty-one (31) years. The study showed that inflation rate, interest rate and money supply exert significant negative impact on economic growth while other variables show significant positive impact on the economic growth (Danladi, 2022).

Adegboyo et al, (2021), adopted endogenous growth model (AK model) as its theoretical framework on examining impact of fiscal, monetary and trade policies on the growth of Nigeria economy applying the Autoregressive Distributed Lag (ARDL) model which revealed that in a long run, fiscal policies stimulated economic growth, while the trade policies discourage the growth of the economy. However, the short run shows that fiscal policies has inconsistent impact on Nigerian economic growth which differs from the long run outcome. The studies of deficit finance impact on the economic growth of Nigeria covering from 1981 to 2016, utilizing Autoregressive Distributed Lag (ARDL) model techniques for the regression analysis, shows that government deficit finance over the years had significantly impacted on the output growth of the Nigeria economy (Ali *et al,* 2018).

Macroeconomic variables such as Gross Domestic Product (GDP), Treasury bill, and Inflation rate on unemployment rate covering 2006Q1 to 2018Q4 was investigated using Autoregressive Distributed Lag (ARDL) model to extract the coefficient of long run and short run. They recorded that Gross Domestic Product has a positive significance on unemployment on long run, and in the short run only the GDP add significantly to unemployment rate (Agbolade & Are, 2019)

The Foreign Direct Investment (FDI) inflow in Nigeria was conducted on some macroeconomic variables which includes exchange rate, inflation rate, monetary policy rate and gross domestic product growth rate from 1986 to 2020. They applied Autoregressive Distributed Lag (ARDL) technique, and the bound test shows that the macroeconomic variables and FDI were bound by a long-run relationship, the short-run coefficients indicated that inflation and exchange rate were the major macroeconomic

variables that significantly reduced FDI inflow in Nigeria while GDP growth rate and monetary policy rate were positive and significant. The study concluded that in the long-run, GDP growth rate and exchange rate revealed positive impact on FDI inflow while the impact of monetary policy rate was negative and significant (Anochie *et al,* 2022). The external debt on economic growth of Nigeria was studied from 1990 to 2020, they employed the Autoregressive Distributive lag (ARDL) techniques for the analysis, and it showed that external debt has negative and insignificant implication on economic growth in Nigeria, exchange rate that has also affected public debt stock and value was negative and significant in influencing the economic growth, and also, gross fixed capital formation was positive and significant in influencing growth. Hence, the foreign direct investment should be encouraged (Meshach *et al,* 2024).

The battle to stabilize the Nigeria economy by the stake holders had be on top gear, which lead to the evaluation of inflation on the Nigeria economic growth for the last four decades starting from 1980 to 2019, where GDP is the dependent variables among other macroeconomic variables considered. They used Autoregressive Distribution Lag (ARDL) model and the Error Correction Model (ECM), the long-run and short-run relationship between variables was also investigated, and it revealed that among the variables, inflation rate has negatively affect the growth of the economic, while the interest rate maintained a positive relationship (Onwubuariri *et al,* 2021)

(Lawal & Abdulrazak, 2022), examined a determinants of exchange rate volatility were assessed through a quarterly time series data from 1981 to 2019 with Augumented Dickey- fuller(ADF) stationarity test used, ARCH and GARCHjohansen cointegration and Vector Error Correction(VECM) model. The results showed that there was short run and long run relationship between exchange rate volatility among the macroeconomic variables considered, in addition it was noted that changed in money supply is money supply is positively related to changes in exchange rate volatility and the GARCH (1.1) shows that GDP, INFL and MCAP had negative impact on mean value of exchange rate volatility except trade balance which is statistically in significant. Bashir *et a*l, (2020) explained the impact of government expenditure on Nigeria economic growth with time series covering the period of 1970 – 2017. They used the modified endogenous growth model with six macro-economic variables, and the study revealed that capital and recurrent variables are statistically significant which explain the impact of government expenditure on economic growth. Also, among the variables, labour and Inflation were seen to have stable long run equilibrium relationship between the dependent variables.

Sources of Data

The Secondary data for the study was sourced from reputable economic databases, which includes the Central Bank of Nigeria (CBN) and the National Bureau of Statistics (NBS). The dataset encompasses historical time-series data for macroeconomic variables such as inflation rate, interest rate, trade balance and exchange rates for a period of 30 years. and is the data collected is a yearly dataset.

The ARDL Model

The Autoregressive Distribution Lag (ARDL) model was used to estimate exchange rate volatility, and also a time series econometric model that captures the volatility clustering phenomenon often observed in financial data. In the case where the variables in the long-run relation of interest are trend stationary, the general practice has been to de-trend the series and to model the de-trended series as stationary distributed lag or autoregressive distributed lag (ARDL) models.

The general ARDL(*p;q*) model.

$$y_t = \alpha_0 + \alpha_1 t \sum_{i=1}^{p} \phi_i \, y_{t-1} + \beta' \mathrm{x}_t \sum_{i=0}^{m-1} \beta_i' \Delta \mathrm{x}_{t-1} + u_t \quad (1)$$

$$¢xt = P1¢xt¡1 + P2¢xt¡2 + ¢¢¢ + Ps¢xt¡s + \varepsilon_t \quad (2)$$

where X_t is the *k*-dimensional I(1) variables that are not cointegrated among themselves, u_t and "t are serially uncorrelated disturbances with zero means and constant variance-covariances, and P_i are cefficient matrices such that the vector autoregressive process in $¢\boldsymbol{xt}$ is stable. We also assume that the roots of all fall outside $1 - \sum_{i=1}^{p} \phi_i \, z^i = 0$

In the case where μ_t and ε_t are correlated the ARDL specification needs to be augmented with an adequate number of lagged changes in the regressors before estimation and inference are carried out. The degree of augmentation required depends on whether $q > s + 1$or not. Denoting the contemporaneous correlation between μ_t and ε_t by the k x 1 vector **d**, the augmented version of equation (1) can be written as

$$y_t = \alpha_0 + \alpha_1 t \sum_{i=1}^{p} \phi_i \, y_{t-1} + \beta' \mathrm{x}_t \sum_{i=0}^{m-1} \pi_i' \Delta \mathrm{x}_{t-1} + n_t \quad (3)$$

where *m = max(q, s+1)*$\pi_i' = \beta_i^* - P_i^* d, i = 1, 2, 3, \ldots, m-1$ where I_k is a k x k identity matrix, $\beta_i^* = 0 \; for \; i \geq q, and \; P_i = 0, for \; i \geq s$.In this augmented specification n_t and $\varepsilon_t$are uncorrelated and the results stated above will be directly applicable to the ordinary least square (OLS) estimators of the short-run and long-run parameters of equation (3).

The use of the ARDL estimation procedure is directly comparable to the semi parametric, fully-modified OLS approach estimation of co-integrating relations. In the static formulation of the co-integrating regression;

$$y_t = \mu + \delta_t + \theta' x_t + v_t, \quad (4)$$

Where; $\Delta x_t = e_t, and \; \varepsilon_t = (v_t, e_t')'$follows a general linear stationary process, the OLS estimators of$\delta \; and \; \theta$ *are* $T^{\frac{3}{2}}$ – and T-consistent, but in general the asymptotic distribution of the OLS estimator of θ involves the unit-root distribution as well as the second-order bias in the presence of the contemporaneous correlations that may exist between v_t and e_t. (source?)

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RESULTS AND DISCUSSION

Table 1. Descriptive Statistics

Variable	LNGDP	LNEX	LNINF	LNINT	LNTRB
Mean	10.63020	4.686703	2.433918	1.436882	15.90676
Median	10.67790	4.883910	2.557230	1.373590	15.98420
Maximum	11.22040	6.054390	3.060580	2.813010	16.44180
Minimum	9.983200	2.850610	0.262360	0.343940	11.45530
Std. Dev.	0.460866	0.968097	0.526368	0.629933	0.854630
Skewness	-0.159270	-0.706907	-2.247189	0.682564	-4.543333
Kurtosis	1.406287	2.337562	9.814229	3.006725	23.90830
Jarque-Bera	40.94151	37.78428	1032.814	28.88612	8055.731
Probability	0.000000	0.000000	0.000000	0.000001	0.000000
Sum	3954.434	1743.453	905.4174	534.5201	5917.314
SumSq. Dev.	78.79961	347.7054	102.7906	147.2186	270.9757
Observations	372	372	372	372	372

The table 1 above presented a description of the variables under consideration. The close proximity of the mean (10.63) and median (10.68) LNGDP values suggests a stable central tendency with minor skewness, implying that economic growth has been reasonably consistent throughout time. The figures for LNGDP range from 9.98 to 11.22, indicating moderate variability in Nigeria's economic growth. This shows that, despite certain variations, overall economic performance has maintained within an expected range. LNGDP has a standard deviation of 0.46, indicating moderate volatility, which totally concord with (Nnachi *et al,* (2023) on Unemployment and Economic Growth that the R square value of about 0.61 percent indicating that gross domestic product accounts for about 61 per cent of the variation in unemployment rate in Nigeria.

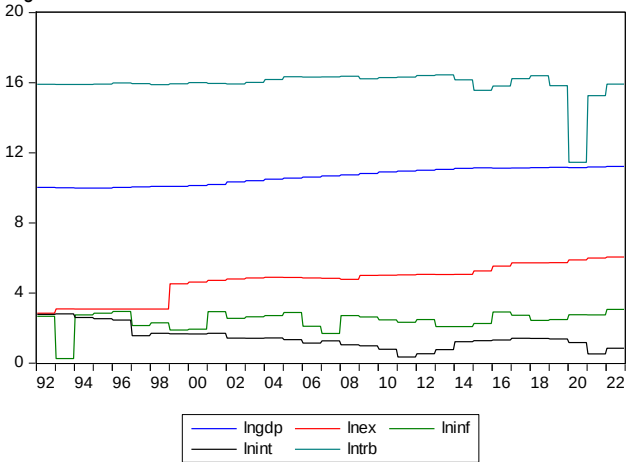

Figure 1. Plot of the variables under review.

The plot revealed that the variables exhibit dynamic behaviour, though LNGDP exemained relatively stable during certain periods. LNTRB showed increased variability, especially toward the end, while LNINF displayed fluctuations from the start through the end of the plot. LNINT was stable at first but began to decline around the middle of the period. Lastly, LNEX increased steadily from the start to the end of the plot. This suggests that a dynamic time series model would be suitable for analysing the relationships among these variables.

Table 2: Augmented Dickey-Fuller Unit Root Test

Variables	Lag	t-statistic	Probability	Order of integration
LnGDP	0	-2.869134	0.0000	1(1)
LnEX	0	-2.869134	0.0000	1(1)
LnINF	0	-2.869374	0.0014	1(0)
LnINT	0	-2.869134	0.0000	1(0)
LnTRB	0	-2.869374	0.0297	1(0)

The Augmented Dickey-Fuller (ADF) Unit Root Test results evaluate each variable's stationarity and their integration order. This test checks if a time series has a unit root, indicating non-stationarity. A stationary series, with constant mean and variance over time, is crucial for reliable time series analysis. For LNGDP, the test result shows a t-statistic of -2.869134 and a p-value of 0.0000, indicating that LNGDP is non-stationary in its level form. It becomes stationary only after first differencing, denoted as I(1). This suggests that economic growth data displays trends or persistent patterns, requiring one differencing step to achieve stability.

Table 3. Selected Model: ARDL (4,1,0,1,1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LNGDP(-1)	0.912320	0.051643	17.66590	0.0000
LNEX	0.016781	0.009489	1.768499	0.0778

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LNINF	0.000576	0.001505	0.382565	0.7023
LNINT	-0.036441	0.010141	-3.593549	0.0004
LNTRB	0.005167	0.002536	2.037110	0.0424
C	0.084531	0.040981	2.062698	0.0399
R-squared	0.999024			
F-statistic	33140.58			
Prob(F-statistic)	0.000000			

The ARDL (4,1,0,1,1) model estimation explores the relationship between economic growth (LNGDP) and other macroeconomic factors, specifically exchange rate (LNEX), inflation (LNINF), interest rate (LNINT), and trade balance (LNTRB). The R-squared value of 0.9990 displayed that 99.9% variation in economy was jointly caused by the independent variables. Again, this very high R-squared value suggested that the model explains approximately 99.9% of the variation in LNGDP, indicating a strong model. Furthermore, the F-statistic value of 33140.58 and a p-value of 0.0000 suggested that the independent variables jointly have a significant impact on LNGDP. Additionally, coefficient of 0.9123 for GDP with p-value of 0.0000, this significant coefficient suggested that past GDP strongly influences current GDP, with a high degree of persistence in economic growth over time. Apparently, the outcome above aligns with predicting gross domestic product to macroeconomic indicators shows the accuracy of 89% and a mean square error of -7.55200 predicted GDP to macroeconomic indicators accurately, more than other methods (Agu *et al,* 2022).

Table 4. ARDL Error Correction Regression: Dependent variable LNGDP

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LNGDP(-1))	-0.077038	0.050741	-1.518238	0.1298
D(LNGDP(-2))	-0.077038	0.050741	-1.518238	0.1298
D(LNGDP(-3))	-0.077038	0.050741	-1.518238	0.1298
D(LNEX)	0.016781	0.009322	1.800090	0.0727
D(LNINT)	-0.036441	0.009949	-3.662706	0.0003
D(LNTRB)	0.005167	0.002473	2.089381	0.0374
CointEq(-1)*	-0.010642	0.001876	-5.674406	0.0000

This ARDL Error Correction Regression model provides insights into the short-run dynamics and speed of adjustment to the long-run equilibrium in relation to economic growth (LNGDP) and other macroeconomic variables considered. The coefficient (-0.0106) indicates the speed at which GDP returns to equilibrium after a short-term shock. Specifically, about 1.06% of the deviation from the long-run equilibrium is corrected each period, suggesting a slow adjustment process towards the long-run equilibrium.

Table 5. F-Bound Test

Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	5.292153	10%	2.2	3.09
k	4	5%	2.56	3.49
		2.5%	2.88	3.87
		1%	3.29	4.37

The F-Bound Test in Table 5 evaluateds the presence of a long-term (level) relationship between the dependent variable (LNGDP) and the independent variables. At 5% significance level, the I(0) bound is 2.56, and the I(1) bound is 3.49.The calculated F-statistic (5.292153) is greater than the I(1) bound (3.49) across all significant le vels (10%, 5%, 2.5%, and 1%).Since the F-statistic exceeds the upper bound (I(1)) at each significantce level, the study we reject the null hypothesis of "no levels relationship," and this indicates that there is a long-term cointegrating relationship between LNGDP and the other macroeconomic variables. The F-Bound Test provides evidence of a stable, long-term relationship between Nigeria's GDP and the chosen macroeconomic indicators, supporting the model's ability to explain long-run economic growth dynamics in relation to these factors.

Table 6. ARDL Long Run Form and Bounds Test
Dependent Variable: D(LNGDP), Selected Model: ARDL (4, 1, 0, 1, 1)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.084531	0.040981	2.062698	0.0399
LNGDP(-1)*	-0.010642	0.003751	-2.837027	0.0048
LNINF**	0.000576	0.001505	0.382565	0.7023
D(LNEX)	0.016781	0.009489	1.768499	0.0778
D(LNINT)	-0.036441	0.010141	-3.593549	0.0004
D(LNTRB)	0.005167	0.002536	2.037110	0.0424

Source: Eview

Table 6. above, examined both long-term and short-term effects of macroeconomic variables on Nigeria GDP (LNGDP). The table shows GDP responds to changes in the independent variables and coefficient value of -0.0106 and p-value of 0.0048 for GDP. The lagged GDP term has a negative and significant coefficient. This implies a long-run adjustment toward equilibrium, suggesting that deviations from GDP's equilibrium level are corrected over time. The negative coefficient signifies that when GDP is above its equilibrium, it tends to adjust downward in future periods. This truly attest to the influence of innovations in monetary policy on the rate of exchange volatility in Nigeria, where in the long run, all monetary policy variables have significant long run relationship with volatility in exchange rate However, money supply and exchange rate have short run effect on the volatility in the exchange rate which is in agreement to the results of (Gbalam *et al*, 2021)

Thus far, the study shows that economic growth has high persistence with a significant coefficient of 0.9123 for past GDP and p-value of 0.0000, Exchange rate positively influences growth slightly with coefficient of 0.0168, and p-value of 0.0778, and Inflation has no significant short-term effect on GDP with the coefficient of 0.0006, and p-value of 0.7023. Higher interest rates

significantly reduce growth with coefficient of -0.0364, and p-value 0.0004. A positive trade balance boosts economic growth by 0.0052 coefficient, and p-value 0.0424.

Conclusion

Therefore, the economic growth is mainly driven by past GDP, interest rates, and trade balance, with moderate influence from exchange rates, while inflation does not significantly impact short-term GDP growth, but however its worth to know that high interest rates hinder growth, while a strong trade balance supports it.

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