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## Econometric Framework for Assessing the Impact of Private and Public Investment on Real GDP in Nigeria Using ARDL-ECM Technique

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**Abstract.** Nigeria's economic growth performance has remained volatile despite sustained increases in both private and public investment over the years. This paradox raises concerns about the effectiveness, efficiency, and dynamic impact of different forms of investment on real gross domestic product (GDP). In the present study, real GDP was used as the dependent variable, while private investment, public investment, real interest rate, political stability, labour force participation, balance of trade, and inflation served as explanatory variables. The ARDL bounds test was applied to determine long-run relationships, and an Error Correction Model estimated short-run dynamics where cointegration existed. Stationarity was tested using the Augmented Dickey–Fuller test, while diagnostic tests ensured model reliability. Annual data from 1994–2023 were sourced from official databases and analyzed using EViews 10. The results indicated wide variation among Nigeria's macroeconomic variables between 1994 and 2023. Inflation averaged 16.64% (max 72.84%), real interest rate averaged 3.54% (min –31.45%), and private investment averaged ₦9,001.31 billion, showing relative stability. Unit root tests revealed a mix of I(0) and I(1) variables, validating the ARDL method. The bounds test confirmed long-run relationships ( $F = 39.46 > 3.18$ ). Long-run estimates showed private investment significantly increased GDP (4.55,  $p < 0.01$ ), while labour force participation (0.45) and balance of trade (0.64) were positive; inflation reduced growth (–0.05). Short-run results showed negative effects from private investment (–0.15) and inflation (–0.0013), with a 5% adjustment speed to equilibrium. The study concludes that policies aimed at improving the efficiency of public investment and strengthening the private sector investment climate are critical for sustaining long-term economic growth in Nigeria.

**Keywords:** Private investment; Public investment; Real GDP; ARDL-ECM; Nigeria

## A. INTRODUCTION

A longstanding problem in macroeconomic research is determining the extent to which private and public investment influence real gross domestic product (GDP). Policymakers often assume that investment drives economic growth, yet the relative contribution of the private versus public sector remains debated. This issue is particularly pressing for developing countries, where fiscal constraints, institutional weaknesses, and unstable macroeconomic environments can distort investment outcomes (Mose et al., 2024). An econometric framework is necessary to empirically disentangle the separate and interactive effects of private and public capital formation on real GDP and to guide effective policy interventions.

The theoretical underpinning of investment–growth analysis traces back to the Solow growth model, which highlights capital accumulation (both private and public) as a key growth driver. Public investment in infrastructure and services can increase productivity by reducing transaction costs and providing essential public goods, potentially crowding in private investment when efficiently deployed (Mose et al., 2024). Conversely, poorly targeted public capital may crowd out private investment, especially when financed through distortionary taxes or high borrowing costs.

Empirically, the relationship between investment and GDP is modeled using time series or panel data econometrics. A common approach is to specify real GDP as a function of private investment, public investment, and control variables (such as interest rates, inflation, and trade openness). The Autoregressive Distributed Lag (ARDL) technique is widely used in recent studies to capture both short-run and long-run dynamics between the variables while accommodating mixed orders of integration (Saleem et al., 2020). For example, in Nigeria, ARDL bounds testing revealed significant long-run linkages among GDP, private investment (proxied by gross fixed capital formation), and public investment (proxied by government capital spending), lending empirical support to the notion that both types of investment matter for growth.

In cross-country analyses, panel data methods such as fixed effects or random effects models are used to exploit variation across countries and time. Panel data estimation helps control for unobserved heterogeneity and increases estimation precision. For instance, Mose et al. (2024) constructed panel data for Ghana and Kenya and found that disaggregating public and private investment provided clearer insight into each component's separate growth effects. Similarly, dynamic panel estimators (e.g., system GMM) can address endogeneity concerns arising from reverse causality between GDP and investment decisions, offering more reliable parameter estimates.

Recent advances in econometric analysis increasingly emphasize the role of structural and investment shocks in explaining growth dynamics. Using local projection techniques, recent studies show that unexpected changes in public and private investment significantly influence GDP growth, with public investment exerting stronger countercyclical effects during economic downturns. This approach aligns with evidence that policy and institutional shocks shape economic outcomes across sectors (Odimegwu & Odumodu, 2020; Odimegwu & Anyakora, 2023). In contrast to static models, shock-based frameworks better capture dynamic adjustments, similar to findings in environmental, fiscal, and policy-oriented studies highlighting context-specific responses to shocks (Odimegwu et al., 2018; Anyakora et al., 2025; Oramah & Chinwe, 2025). Such insights reinforce the need for dynamic econometric tools in growth analysis. These approaches extend beyond simple regression by capturing dynamic impulse responses that are critical for policy responses under different economic conditions. The need for the study stems from persistent ambiguity in how distinct investment types influence Nigeria's economic growth.

Although several studies have examined investment and growth, many either overlook the dynamic short-run versus long-run effects or fail to address variable integration

orders (Dinh et al., 2019). For example, existing research often applies static regression models that cannot effectively capture time-lagged relationships between investment and real GDP, leading to biased conclusions about causality (Mose et al., 2024). Additionally, studies focused on Nigeria have seldom used the ARDL-Error Correction Model (ECM) to simultaneously analyze short-run dynamics and long-run equilibrium relationships between private investment, public investment, and GDP (Sheikh et al, 2026). This gap is critical, as Nigeria's economy experiences frequent structural breaks due to policy shifts and macroeconomic shocks, making traditional models inadequate. Therefore, employing the ARDL-ECM technique provides a more robust framework that accounts for mixed order of integration, endogeneity, and temporal adjustment processes, ultimately yielding deeper insights into how investment strategies can be optimized to foster sustainable real GDP growth.

#### Research Question

Following the statement of the problem, this study is aimed at providing answers to the questions posed below:

To what extent do private investment and public investment affect economic growth in Nigeria?

#### Objectives of the study

To investigate the extent to which PRIV and PUIV affect economic growth in Nigeria.

## B. LITERATURE REVIEW

The empirical literature on the relationship between investment components and economic growth is extensive and reveals both convergence and divergence in findings, depending on country context, methodology, time period, and the type of investment considered. Collectively, these studies provide a strong foundation for understanding how public investment, private investment, foreign direct investment (FDI), infrastructure investment, and capital formation interact to influence economic growth.

A substantial strand of the literature emphasizes the complementary roles of public and private investment in driving economic growth. For instance, Ahamed (2022), using mixed-effect and Bayesian logistic regression models across emerging economies from 1990 to 2019, finds that both public and private investments significantly promote economic growth, although the magnitude and direction of effects differ across components. While private investment and domestic credit positively affect growth, FDI exerts a negative influence in some contexts, suggesting absorptive capacity constraints. Importantly, public investment especially through capital formation, labor growth, and government consumption which emerges as a major driver of growth in developing economies.

Country-specific evidence from Nigeria reinforces these conclusions while highlighting nonlinear and regime-dependent effects. Akinlo (2022), employing a Markov Regime-Switching framework, demonstrates that both public and private investments positively influence growth, but their relative effectiveness depends on the business cycle. Private investment dominates during economic expansions, whereas public investment is more growth-enhancing during contractions. This supports the neoclassical emphasis on savings and investment while acknowledging structural asymmetries across regimes. Similarly, studies such as Amade et al. (2022), Ogunjinmi (2022), and Eze and Nwachukwu (2022) show that domestic investment, public investment, and FDI contribute to growth in both the short and long run, although short-run effects are often weaker or even negative due to adjustment costs and macroeconomic instability.

Beyond Nigeria, regional and cross-country studies further enrich the debate. Bah and Kpognon (2021), focusing on ECOWAS countries, reveal that public investment has a strong and positive long-run impact on growth, particularly when supported by good governance, political stability, and the rule of law. This institutional dimension underscores that investment effectiveness is conditional on administrative quality. In a similar vein, Abubakar et

al. (2019) and Adeniyi (2022) confirm that both public and private investments stimulate growth in ECOWAS and Sub-Saharan Africa, with private investment often exerting a slightly stronger effect. However, infrastructure investment tends to yield slower returns, indicating the importance of efficiency and timely execution.

The role of FDI remains contested across studies. While Amade et al. (2022), Chen et al (2023) report positive and significant effects of FDI on growth which often mediated through technology transfer and innovation which other studies, such as Ahamed (2022), find negative or insignificant effects in certain developing regions. These mixed results suggest that the growth impact of FDI depends heavily on domestic absorptive capacity, institutional quality, and the sectoral allocation of foreign capital. Infrastructure investment is consistently identified as a critical channel through which public investment affects economic growth, particularly by strengthening human capital, productivity, and the quality of the built environment. Studies show that investments in physical and social infrastructure enhance employee productivity and institutional efficiency (Mbuba, 2022), while weak infrastructure regulation contributes to structural failures and economic losses (Ike et al., 2021). Improved educational and social infrastructure supports employability and development outcomes (Morah et al., 2022).

Additionally, residential and urban infrastructure quality influences socioeconomic wellbeing (Okafor et al., 2022), whereas inadequate energy infrastructure generates environmental and health externalities that constrain growth (Onwuka et al., 2017). Johnson and Adebisi (2020), Sulaimon et al (2024), and Akinlo and Adejumo (2019) demonstrate that investments in energy, transportation, and physical infrastructure significantly enhance growth in Sub-Saharan Africa and Nigeria. Nonetheless, their effectiveness is moderated by project management efficiency, fiscal sustainability, and governance structures. Some studies, such as Makuyana and Odhiambo (2019) on Malawi, even find that public investment can crowd out private investment or exert negative long-run effects if poorly allocated, reinforcing the need for strategic investment planning.

Evidence from Asia, Europe, and Latin America further broadens the perspective. Unnikrishna and Kattookaran (2020) in India, Müller and Braun (2019) in the European Union, and D-Maria et al. (2020) in Latin America all confirm that both public and private investments are essential for growth, though their temporal impacts differ. Public investment tends to support long-run growth through infrastructure and institutional capacity, while private investment drives short-run growth dynamics and innovation. In China, Chen et al (2023) show that domestic private investment and FDI significantly boost growth, especially when innovation acts as a mediating factor, whereas government investment alone becomes less effective without complementary technological progress.

Earlier Nigerian studies, including those by Kingsley and Oke (2025), Emmanuel and Kehinde (2018), Oladipo (2017), and Egbetunde and Fadeyibi (2015), consistently find a positive long-run relationship between investment and economic growth. However, they also highlight important nuances: private investment often dominates in the long run, public investment is more effective in the short run, and sectoral composition matters greatly. Government investment in productive sectors such as infrastructure, education, and health yields better growth outcomes than administrative or recurrent spending. The literature suggests a broad consensus that investment whether public, private, domestic, or foreign which is a fundamental driver of economic growth. Yet, its impact is neither uniform nor automatic. The effectiveness of different investment components depends on macroeconomic stability, institutional quality, governance, innovation capacity, and the interaction between public and private sectors.

### C. RESEARCH METHODOLOGY

The study objective is to investigate the impact of private and public investments on economic growth in Nigeria. In a functional form, the model is specified as:

$$RGDP = f (PRIV, PUIV, RINR, PSAV, LFPR, BTD, INFL) \tag{1}$$

Transforming equation 3.8 into a generalized form of the ARDL model, the following econometric specification is given as:

$$\begin{aligned} LOGRGDP_t = & \alpha_0 + \sum_{j=1}^Z \phi_j LOGRGDP_{t-j} + \sum_{i=0}^X \theta_i LOGPRIV_{t-i} + \sum_{k=0}^X \lambda_k PUIV_{t-k} \\ & + \sum_{m=0}^X \delta_m RINR_{t-m} + \sum_{s=0}^X \rho_s PSAV_{t-s} + \sum_{n=0}^X \Omega_n LFPR_{t-n} + \sum_{p=0}^X \psi_p LOGBTD_{t-p} \\ & + \sum_{q=0}^X \vartheta_q INFL_{t-q} + \mu_t \end{aligned} \tag{2}$$

To perform the bounds test for cointegration, the conditional ARDL model is specified thus;

$$\begin{aligned} \Delta LOGRGDP_t = & \alpha_0 + \beta_j LOGRGDP_{t-j} + \gamma_i LOGPRIV_{t-i} + \delta_k PUIV_{t-k} + \pi_m RINR_{t-m} \\ & + \sigma_s PSAV_{t-s} + \vartheta_n LFPR_{t-n} + \infty_z LOGBTD_{t-z} + \varphi_q \Delta INFL_{t-q} \\ & + \sum_{j=1}^Z \phi_j \Delta LOGRGDP_{t-j} + \sum_{i=0}^X \theta_i \Delta LOGPRIV_{t-i} + \sum_{k=0}^X \lambda_k \Delta PUIV_{t-k} \\ & + \sum_{m=0}^X \delta_m \Delta RINR_{t-m} + \sum_{s=0}^X \rho_s \Delta PSAV_{t-s} + \sum_{n=0}^X \Omega_n \Delta LFPR_{t-n} \\ & + \sum_{p=0}^X \psi_p \Delta LOGBTD_{t-p} + \sum_{q=0}^X \vartheta_q \Delta INFL_{t-q} \\ & + \mu_t \end{aligned} \tag{3}$$

The hypotheses for the bounds test, which show that the coefficients of the long-run equation are all equal to zero against the alternative that they are not equal to zero, are stated below;

$$H_0 : \beta_j = \gamma_i = \delta_k = \pi_m = \sigma_s = \infty_z = \varphi_q = 0$$

$$H_1 : \beta_j \neq \gamma_i \neq \delta_k \neq \pi_m \neq \sigma_s \neq \infty_z \neq \varphi_q \neq 0$$

We can only specify the short-run model, which is the ARDL model, if we are unable to reject the null hypothesis (that is, there is no cointegration).

The ARDL model is specified as;

$$\begin{aligned} \Delta LOGRGDP_t = & \alpha_0 + \sum_{j=1}^Z \phi_j \Delta LOGRGDP_{t-j} + \sum_{i=0}^X \theta_i \Delta LOGPRIV_{t-i} + \sum_{k=0}^X \lambda_k \Delta PUIV_{t-k} \\ & + \sum_{m=0}^X \delta_m \Delta RINR_{t-m} + \sum_{s=0}^X \rho_s \Delta PSAV_{t-s} + \sum_{n=0}^X \Omega_n \Delta LFPR_{t-n} \\ & + \sum_{p=0}^X \psi_p \Delta LOGBTD_{t-p} + \sum_{q=0}^X \vartheta_q \Delta INFL_{t-q} \\ & + \mu_t \end{aligned} \tag{4}$$

We can specify both the short-run and long-run models, which is the error correction model (ECM), if we can reject the null hypothesis (that is, there is cointegration). The error correction model (ECM) representation is specified as;

$$\begin{aligned} \Delta \text{LOGRGDP}_t = & \alpha_0 + \sum_{j=1}^Z \phi_j \Delta \text{LOGRGDP}_{t-j} + \sum_{i=0}^X \theta_i \Delta \text{LOGPRIV}_{t-i} + \sum_{k=0}^X \lambda_k \Delta \text{PUIV}_{t-k} \\ & + \sum_{m=0}^X \delta_m \Delta \text{RINR}_{t-m} + \sum_{s=0}^X \rho_s \Delta \text{PSAV}_{t-s} + \sum_{n=0}^X \Omega_n \Delta \text{LFPR}_{t-n} \\ & + \sum_{p=0}^X \psi_p \Delta \text{LOGBTD}_{t-p} + \sum_{q=0}^X \vartheta_q \Delta \text{INFL}_{t-q} + \gamma \text{ECT}_{t-1} \\ & + \mu_t \end{aligned} \quad 5$$

Where PRIV = private investment, PUIV = public investment (composed of the sum of government capital expenditure on economic and social community services as % of GDP), LFPR = labour force participation rate, PSAV = political stability and absence of violence/terrorism, BTD = balance of trade, and INFL = inflation rate.

Private investment drives capital accumulation and technological innovation, directly fueling GDP growth. Empirical studies in Nigeria, such as Ajakaiye and Fakiyesi (2017), have found a significant positive relationship between private-sector capital formation and real output, justifying its inclusion as a core determinant of RGDP. Public investment in infrastructure and social services creates the groundwork for private-sector productivity and has been adopted by Anyanwu (2019) in a study. The real interest rate influences borrowing costs and investment incentives. Adeoye and Joshua (2018) showed that higher real rates in Nigeria crowd out private credit, dampening capital formation and slowing GDP growth, making the real interest rate essential for capturing monetary-policy effects. Political stability reduces uncertainty and risk premiums, fostering both domestic and foreign investment, and has been used by Odhiambo (2010). LFPR measures the active labour supply, a key factor in production capacity, and has been adopted by Iyoha (2004). Net exports contribute directly to GDP via the trade balance. Nwosa and Osinubi (2016) incorporated the balance-of-trade ratio in their model and found that trade surpluses significantly stimulate Nigerian economic growth. Inflation affects real incomes and investment planning and has been employed by Dauda and Usman (2017).

### Justification

**Gross Domestic Product (RGDP):** This is the dependent variable in our model and a proxy for economic growth. It measures the total value of final goods and services produced within the economy at any given period. Precisely, it is defined as a gradual upswing in national revenue or output (Etim et al., 2021). Economic growth is included in the model as it is the primary variable of interest, and it represents the aggregate demand in the economy. It is viewed from the angle of a four-sector economy, which is a function of household consumption, investment, government expenditure, and net export. In this study, gross domestic product is measured in billions of dollars (constant 2015 US\$).

**Private Investment (PRIV):** Private investment refers to the spending on capital goods by individuals and businesses in the private sector. It involves the allocation of funds to purchase physical assets such as machinery, equipment, buildings, and technology with the expectation of generating income or profit in the future. It is a major variable of interest that indicates the private aspect of domestic investment in an economy. It is considered an independent variable in the second model and a moderating variable in the third model. Its justification as an independent variable is based on the fact that private investment is a key driver of economic growth, as it contributes to the expansion and improvement of productive capacity within an economy. Its role as a moderating variable lies in the fact that tax revenue first has an impact on private investment before it translates to economic growth. It is expected that an increase in private investment should bring about an increase in economic growth and vice versa. It is measured annually in billions of Naira.

**Public Investment (PUIV):** Public investment refers to the spending of public funds on physical and social infrastructure projects by the government (i.e., the sum of government

capital expenditure on economic and social community services as % of GDP). It is the second major aspect of domestic investment in an economy. Its inclusion as an independent variable in the second model is because public investments are intended to provide long-term benefits to society, contribute to economic development, and enhance the overall well-being of the population. Its role as a moderating variable in the fourth model stems from the idea that a portion of public funds spent on public investment is obtained from tax revenue, which is expected to increase economic growth if used efficiently. Public investment is measured annually in billions of Naira.

**Real Interest Rate (RINR):** This is an explanatory variable and is included in this model in line with economic theories that explain the strong impact of interest rates on economic growth through investment. Interest rate is the cost or price of borrowing money, typically expressed as a percentage of the amount borrowed. It is the cost that borrowers incur for using someone else's money. Interest rate is proxied by real interest rate as it accounts for inflation and is a better measure of interest rate over time. It is expected that the interest rate has a negative relationship with economic growth, as an increase in interest rate discourages investment, which reduces economic activity. Interest rate is measured annually in percentage, and its coefficient is negative and less than 1.

**Labour Force Participation Rate (LFPR):** The labor force participation rate is a measure that expresses the percentage of the working-age population (those available and willing to work) that is either employed or actively seeking employment. It is a key indicator used to assess the level of labor market engagement within a given population. It is introduced as an independent variable in this study in line with the neoclassical growth theory. It is expected that an increase in the labour participation rate should increase economic activities in an economy. Hence, its coefficient is positive and greater than 1.

**Balance of Trade:** This refers to the difference between the value of a country's exports and imports of goods and services over a specific period. According to the World Bank, the balance of trade (BoT) is a key component of a nation's current account and reflects its economic interactions with the rest of the world. Because of the role of BoT as an indicator of economic health, exchange rate stability, policy implementation, and macroeconomic stability, it becomes necessary to include it in the study as a control variable.

**Inflation Rate:** It is the percentage change in the average level of prices of goods and services in an economy over a period, typically one year. It is measured by tracking price indices such as the Consumer Price Index (CPI). Inflation is very important in studying investment decisions since it affects the purchasing power of money, which affects the real returns on investment. It also affects real interest rates, asset valuations, business input costs, and economic stability, among others.

#### **Justification of Estimation Technique/Procedure**

This study employed the autoregressive distributed lag (ARDL) model because of its dynamism, that is, the ARDL model is a model containing the lagged values(s) of the dependent variable, the current and lagged values of regressors or explanatory variables, unlike static models. The ARDL model uses a combination of endogenous and exogenous variables, unlike a VAR model, which is strictly designed for endogenous variables. The study is interested in the behavior of our endogenous variables given the exogenous variables.

The ARDL model is a good alternative when Engle and Granger or the two-step procedure breaks down. That is, in time-series analysis, the error term usually suffers from the problem of autocorrelation because the series tends to co-move, and there is a possibility for endogeneity or endogenous regressors. These problems of the static model stated above will render the Engle and Granger or two-step procedure impotent or ineffective; by this, the Autoregressive Distributed Lag (ARDL) model is employed to simultaneously account for long-run and short-run relationships.

This model can also be applied when the variables are of a different order of integration, that is, a mixture of 1(0) and 1(1) (Pesaran & Shin, 1998; Pesaran et al, 2001). In other words, independent variables could be integrated at order zero, order one, a combination

of order zero and order one variables, or mutually cointegrated and avoid problems such as spurious relationships resulting from non-stationary time series data. The ARDL model is relatively more efficient in the case of small finite sample data sizes, by employing the ARDL technique; unbiased long-run estimates are obtained. In the ARDL model, the lag length for Z and X may not necessarily be the same, unlike the VAR model, which must be of equal lag length.

This model is appropriate in capturing all the objectives of this study, given the principle of parsimony, which suggests that we would keep our regression model as simple as possible, as much as we can explain our dependent variable substantially. In general, employing other sophisticated models might or will negate the principle of parsimony, which we have just stated.

### **Evaluation Procedure**

#### **Pre-Estimation Test**

##### **Stationary Test**

Stationary testing holds a significant role in time series analysis. It pertains to the statistical characteristics of a time series (or the process that generates it) remaining constant over time. In essence, stationary testing examines whether the values of variables remain stable over time, meaning that changes in time do not introduce alterations in variable values. To put it simply, this means that both variance and auto-variance remain constant ( $E(Y_1) = E(Y_{t+j}) = \mu$ ;  $\text{Var}(Y_1) = \text{Var}(Y_{t+j}) = \sigma^2 y$ ); in other words, they do not vary with time. Failing to test for non-stationarity can yield spurious results in research, particularly if non-stationary time series are present in the variables of interest, as they can provide misleading outcomes. To conduct a precise analysis of the variable nature, accurate prediction, and forecasting, and gain insights into the true relationship between variables, it is imperative to ensure that the data is devoid of trends and seasonality effects. To achieve optimal results, we employed the Augmented Dickey-Fuller (ADF), which follows a tau-statistic distribution ( $\sim$ ) to test for a unit root because of its lag augmentation process. The tests are conducted for each of the time series variables. A variable is stationary if the absolute ADF value ( $|t|$ ) is greater than any of the absolute Mackinnon tau critical values. The essence of this test is to ascertain that none of the variables employed in this model are integrated at a higher order, that is, order 2 or I(2).

##### **Co-integration Test**

Co-integration testing is employed to ascertain whether there is a long-term correlation among multiple time series. This can involve two variables becoming co-integrated in the long run or establishing an equilibrium relationship between them. The notion was initially introduced by Nobel laureates Robert Engle and Clive Granger in 1987, following the publication of the spurious regression concept by British economists Paul Newbold and Granger. Co-integration tests identify situations in which two or more non-stationary time series are integrated in such a manner that they cannot veer away from equilibrium over the long haul. Co-integration represents a statistical attribute of a set of time series variables, denoted as  $(X_1, X_2, \dots, X_k)$ . Initially, all of these series must be integrated in terms of order. Subsequently, if a linear combination of this set is integrated with an order less than  $d$ , then the set is considered co-integrated. This approach is employed to examine the existence of a long-term relationship between tax revenue and investment in Nigeria.

This examination will be conducted utilizing the long-term and F-Bound co-integration test. Hence, if the trace statistic and the Max-Eigen statistic are greater than the 5% critical values, the null hypothesis of no co-integration will be rejected in favour of the alternative hypothesis at that level.

##### **Post Estimation Test**

##### **Test for Autocorrelation**

Autocorrelation, in the context of time series data, pertains to the existence of a connection between error terms observed across different time points. The Autocorrelation test is employed to assess whether these error terms from distinct time points exhibit a correlation, which contravenes the assumptions of Ordinary Least Squares (OLS).

Autocorrelation manifests itself through OLS estimators that do not qualify as the Best Linear Unbiased Estimates (BLUE). In our research, we utilize the Breusch-Godfrey Serial Correlation test to identify potential autocorrelation in any prediction errors obtained from a regression analysis. This test is employed before the Durbin-Watson test because it is more encompassing and imposes no restrictions. It operates based on the following criteria.

Hypotheses

$H_0$  = Absence of serial correlation

$H_1$  = Presence of serial correlation

**Decision Rule:** If the P value is less than the chosen level of significance (0.05 or 5%), then we reject the null hypothesis that there is no serial correlation and accept the alternative hypothesis that there is a serial correlation.

**Heteroskedasticity Test**

One assumption made in ordinary least squares (OLS) analysis is the constancy of the error term's variance across all observations. When this assumption is violated, it results in the issue known as heteroscedasticity. Even though we won't be conducting OLS estimation, it remains crucial to address heteroscedasticity to establish the reliability of our findings. Neglecting this step can lead to inefficient coefficient estimates, as well as biased standard error estimates, ultimately resulting in inaccurate statistical tests and confidence intervals. Consequently, we will employ the Breusch-Pagan-Godfrey Heteroscedasticity test to verify the robustness of the regression analysis. If the chi-square probability is greater than a 5% level of significance, it means that there is no heteroscedasticity in the data.

**Multi-collinearity test**

Multicollinearity refers to the presence of a perfect or complete linear relationship among one or more of the predictor variables. To determine whether multicollinearity is present among the predictor variables, a multicollinearity test is conducted. When the confidence interval appears significantly wider, it suggests the presence of multicollinearity, resulting in a faster acceptance of the null hypothesis. There are various techniques for detecting multicollinearity, but in this study, the correlation matrix will be employed to assess the existence of multicollinearity among the variables utilized in the model. If the correlation values between the independent variables exceed 0.8, it can be concluded that multicollinearity exists among these variables.

**Stability Test**

The purpose of this test is to verify the stability of the model under examination; if the model is found to be unstable, it may need restructuring. Evaluating model stability involves utilizing CUSUM and CUSUMSQ, where the presence of a blue line between two red lines indicates the stability of the model. However, if the blue line goes outside the red lines, it indicates instability. Two efficient Recursive Residuals methods, namely the Cumulative Sum of Recursive Residuals (CUSUM) and the Cumulative Sum of Square Recursive Residuals (CUSUMSQ), were employed for the stability testing process.

**Data Sources.**

The study adopted secondary time series data for all the variables covering the period from 1994 to 2023. The data was sourced from different areas based on the variable of consideration.

**Table 1: Nature and Sources of Data.**

Variables	Proxy and Measurement	Sources (s)
Economic Growth	Proxied by the real gross domestic product measured in billions of dollars	World Bank Indicators (WDI)
Private Investment	Measured in (Rp) Billion).	CBN
Public Investment	Measured in (Rp) Billion).	CBN

Direct taxation revenue	Proxied by corporate income tax revenue measured in billions of Naira	Federal Inland Revenue Service or <a href="https://www.firs.gov.ng/tax-resources-statistics/CBN">https://www.firs.gov.ng/tax-resources-statistics/CBN</a>
Indirect taxation revenue	Proxied by value-added taxation revenue and is measured in billions of Naira.	Federal Inland Revenue Service/CBN
Real Interest Rate	Proxied by the real interest rate measured in percentage.	World Bank indicators (WDI).
Labour force participation rate	Proxied by the labour participation rate measured in total	World Bank Indicators (WDI)
Balance of trade	Measured in (₦Million).	World Bank indicators (WDI).
Political Stability and Absence of Violence/Terrorism	Measured as estimated	World Governance Indicators (WGI)

Source: Researchers' Compilation 2024.

### Econometric Software Package

The econometric software package employed for this is EViews, Version 10

## D. RESULTS AND DISCUSSION

### Descriptive Statistics of the Variables

The study uses time series data from Nigeria spanning a period of thirty years (1994-2023). The variables of interest here include company income tax, value-added tax, real GDP, labour force participation rate, inflation rate, private investment, public investment, the balance of trade, Political Stability and Absence of Violence/Terrorism, and real interest rate.

Table 2: Descriptive Statistics of the Variables

Variables	Obs.	Mean	Minimum	Maximum	Standard Deviation	Jarque-Bera
LFPR	30	59.79964	58.437	60.422	0.536836	4.899907
INFL	30	16.64427	5.388008	72.8355	14.27973	119.6169
PRIV	30	9001.307	6860.444	11445.86	1302.517	1.709214
PUIV	30	1.628721	0.339018	6.216933	1.392622	25.28422
RINR	30	3.538199	-31.4526	18.18	9.553944	40.92277
BTD	30	1558341	-7905599	5822589	3001525	7.650825
RGDP	30	3.45E+11	1.55E+11	5.51E+11	1.42E+11	3.095398

Source: Author's Computation, E-View 10.

The descriptive statistics in Table 2 summarize thirty annual observations (1994–2023) for ten key macro-fiscal and institutional variables. On average, corporate income tax revenue stood at ₦784.94 billion, and value-added tax revenue at ₦711.63 billion, reflecting their similar magnitudes as major government receipts. Private investment averaged ₦9,001.31 billion, whereas public investment was much lower, at ₦1.63 billion (both in real terms), signaling the dominance of the private sector in capital formation. Real GDP averaged

₹3.45 × 10<sup>11</sup>, capturing the broad scale of national output, and labour force participation hovered around 59.8 percent.

The span between minimum and maximum values, together with standard deviations, highlights considerable heterogeneity across variables. Inflation ranged widely from 5.39 percent to 72.84 percent, with standard deviations of 14.28, illustrating episodes of both relative price stability and severe inflationary shocks. Real interest rates swung from – 31.45 percent to 18.18 percent with standard deviations of 9.55, indicating periods of negative real borrowing costs. The balance of trade exhibited extreme variability (mean = ₹1.56 million, with standard deviations of ₹3.00 million), with both large surpluses and deficits. In contrast, labour force participation and private investment showed much tighter dispersion with standard deviations of 0.54 and 1,302.52, respectively, reflecting more stable trends in labour market engagement and private-sector spending.

Tests for normality via the Jarque–Bera statistic reveal pronounced departures from Gaussian distributions for most series. Inflation (119.62) and real interest rates (40.92) display heavy skewness and/or kurtosis, pointing to the influence of outlier incidents. Corporate tax and VAT revenues also reject normality (91.09 and 78.64, respectively), likely due to structural reforms and revenue volatility over the sample. Only private investment (1.71) and RGDP (3.10) approach normality, suggesting more symmetric and mesokurtic distributions for those aggregates.

#### Unit Root Test

Stationarity is defined as the constancy of statistical characteristics within a time series, such as parameters like mean, variance, and autocorrelation, which remain unchanged over time. This study evaluated stationarity through Augmented Dickey-Fuller (ADF) tests and the Phillips-Perron test conducted on the data to ensure the robustness of the outcome under the following hypothesis. The unit root test is used to determine whether the variables are stationary. Without stationarity, data processing may produce biased results, which in turn lead to unreliable interpretations and conclusions.

Ho: Variable contains a unit root, hence non-stationary.

H1: Variable does not contain a unit root, hence stationary.

Both the original data series and the first-order differenced series are subjected to these tests. If the ADF and Phillips-Perron test statistic values are greater than the critical value at a selected significance level (in absolute terms), the null hypothesis is rejected as part of the selection criterion. Table 3 provides a summary of the ADF and Phillips-Perron unit root test findings, which are available in the Appendix section.

**Table 3: Unit Root Results (Augmented Dickey-Fuller and Phillips-Perron Tests)**

Variables	Test Statistic for ADF Test	5% Critical Value	Test Statistic for Phillips-Perron Test	5% Critical Value	Order of Integration
LFPR	-4.652410	-3.632896	-3.631989	-2.971853	1(0)
INFL	-3.444568	-2.967767	-2.606498	-1.952910	1(0)
PRIV	-5.530631	-3.580623	-5.446741	-3.574244	1(0)
PUIV	-6.201968	-1.955681	-3.443611	-3.574244	1(0)
RINR	-5.643089	-3.587527	-3.985468	-3.574244	1(0)
BTD	-4.472640	-3.603202	-3.511711	-2.971853	1(1)
RGDP	-3.137843	-2.971853	-3.107169	-2.971853	1(1)

Source: Author’s computation (E-views 10)

NA denotes Not Applicable

The summary Table 3 discloses that some of the variables are stationary in levels 1(0), like the company income tax, value-added tax, labour force participation rate, private investment, public investment, and real interest rate. Whereas real GDP, the balance of trade, Political Stability, and Absence of Violence/Terrorism are found to be stationary at first difference 1(1). Therefore, having a mixture of 1(0) and 1(1) orders of integration justifies the use of the ARDL estimation technique.

**Correlation Analysis**

The ordinary correlation matrix provides the opportunity to evaluate the degree of multicollinearity between the series before the estimation is carried out. This only shows the non-existence of multicollinearity within the series. The table below shows the correlation matrix for the various models estimated in this research.

**Table 4: Correlation Matrix of the Variables**

VARIAB LES	RGDP	PRIV	PUIV	RINR	PSAV	LFPR	BTD	INFL
RGDP	1.00000 0							
PRIV	0.71174 4	1.00000 0						
PUIV	0.61778 9	-	1.00000 0					
RINR	0.32076 7	0.25429 1	0.05543 5	1.00000 0				
PSAV	0.65800 5	-	0.62747 6	-	1.00000 0			
LFPR	0.70404 9	-	0.34327 6	-	0.26075 9	1.00000 0		
BTD	0.01597 3	-	-	0.07478 7	-	0.54850 1	1.00000 0	
INFL	0.29817 3	-	-	-	0.47798 7	0.10586 2	0.15554 0	1.00000 0

**Test for Cointegration- Bounds Test**

**Table 5: Bounds Test Result**

Test Statistic	Value	K
F-Statistic	39.45655	7
Critical Value Bounds		
Significance	1(0) Bound	1(1) Bound
10%	1.7	2.83
5%	1.97	3.18
2.5%	2.22	3.49
1%	2.54	3.91

Source: Author's computation (E-views 11)

**Decision Rule:** We reject the null hypothesis since the test statistic (F-statistic = 39.4566) is greater than the upper bounds at a 5% level of significance [1(1) Bound = 3.18], and consequently conclude that a long-run relationship exists in the model. This test verifies if there exist long-run relationships amongst the related variables of interest.

**Estimation and Interpretation**

The ARDL model, having been established to possess a long-run relationship, is presented in summary in Table 4.10 below:

**Table 6: Model Estimation Result (Long-run)**

**Dependent Variable: LOGRGDP**

Variables	Coef.	Std. Error	Prob.	Coef.	Std. Error	Prob.
<b>ARDL ESTIMATOR</b>			<b>FMOLS ESTIMATOR</b>			

LOGPRIV	4.5522*	0.7318	0.0008	0.7682*	0.258661	0.0073
PUIV	0.5546	0.3250	0.1388	0.0586	0.060478	0.3438
RINR	-0.0118	0.0197	0.5700	0.0155*	0.004231	0.0014
PSAV	0.0410	0.7310	0.9571	-0.7238*	0.180287	0.0006
LFPR	0.4477**	0.1550	0.0277	-0.2162*	0.063443	0.0026
LOGBTD	0.6434**	0.2285	0.0305	0.0340	0.023064	0.1550
INFL	-0.0524**	0.0142	0.0101	0.0149*	0.004109	0.0016

Source: Author's computation, E-views 10

Note: \* denotes significance at 1%, \*\* denotes significance at 5%

The estimated outcome in Table 6 indicates that a unit increase in private investment would cause real output to rise by a margin of 4.55 points and was found to be statistically significant at the 1% level of significance. The result is supported by the works of Ahamed (2022), Akinlo (2022), Unnikrishna and Kattookaran (2020), Makuyana and Odhiambo (2019), and Fatima (2012). Contrary to their finding, private investment has a negative impact on the economy, which was supported by the works of Ozoh et al. (2016).

One percent increase in public investment will result in a 55.5% increase in real GDP, and was found not to be statistically significant in the long run. Although the works of other scholars like Ahamed (2022), Akinlo (2022), Bah and Kpognon (2021), Unnikrishna and Kattookaran (2020), Emmanuel and Kehinde (2018), and Fatima (2012) found a significant impact, the current research disclosed an insignificant impact, but all had a positive impact on real output. The work of Makuyana and Odhiambo (2019) and Ilegbinosa, Michael, and Watson (2015) showed that public investment has a negative effect on real output, therefore, disclosing a contrary effect against the findings of the study.

For every one percent increase in labour force participation rate in Nigeria, the real output will roughly surge by 45%, and it is statistically significant at the 5% level. The outcome of the analysis is supported by the work of Ahamed (2022). Also, a unit increase in the balance of trade would cause the real output level to rise by 0.643 points, and this finding is statistically significant at 5% level of significance. Finally, the inflation rate in the country is having a negative effect on real output, as a unit change in the level of inflation results in about a 5.2% drop in the country's economic output, and it is statistically significant at 5%. The economic signs of the three discussed control variables are in order.

**A side-by-side comparison of the long-run estimates from the ARDL model (the baseline) and the FMOLS model (robustness check)**

For private investment, ARDL reports a very large positive coefficient of 4.5522 (1% significant), whereas FMOLS finds a much smaller but still significant effect of 0.7682. Public investment is positive yet insignificant in both ARDL (0.5546, prob. value = 0.14) and FMOLS (0.0586, prob. value = 0.34). Real interest rate flips sign: ARDL's estimate is negative and insignificant (-0.0118, prob. value = 0.57), but FMOLS shows a significant positive impact (0.0155, prob. value = 0.0014). Political stability is inconsequential in ARDL (0.0410) yet significantly negative under FMOLS (-0.7238, prob. value = 0.0006). Labour force participation rate is positive and significant in ARDL (0.4477, prob. value = 0.0277) but negative and significant in FMOLS (-0.2162, prob. value = 0.0026). Balance of trade is significant only in ARDL (0.6434, prob. value = 0.0305), while inflation is negative and significant in ARDL (-0.0524, prob. value = 0.0101) but positive and significant in FMOLS (0.0149, prob. value = 0.0016). Thus, the two estimators diverge sharply on both magnitude and sign for several controls, highlighting estimator sensitivity.

**Table 7: Model Estimation Result (Short-run)**

Dependent Variable: LOGRGDP

Variables	Coefficient	Std. Error	t-statistic	Prob.
D(LOGPRIV)	-0.1478*	0.0186	-7.9431	0.0002
D(PUIV)	0.0018	0.0041	0.4400	0.6753
D(PSAV)	-0.1079*	0.0156	-6.9285	0.0004
D(LFPR)	0.1077*	0.0193	5.5753	0.0014

D(LOGBTD)	-0.0223*	0.0024	-9.3407	0.0001
D(INFL)	-0.0013**	0.0003	-4.9012	0.0027
CointEq(-1)*	0.0481*	0.0018	26.152	0.0000

Source: Author's computation, E-views 10

Note: \* denotes significance at 1%, \*\* denotes significance at 5%

From Table 7, it is observed that the estimates of the immediate differential of private investment, political stability, absence of violence/terrorism, the balance of trade, and inflation rate all had a negative impact on real output in Nigeria, while public investment and labour force participation rate have a positive effect on real output. According to the result, a unit increase in private investment, on average, decreases real output by 0.148 points in the current period, which is in the short run. Similarly, the estimate of political stability and absence of violence/terrorism has a negative impact on real output in Nigeria. This is shown from the estimate that a 1% increase in political stability and absence of violence/terrorism during the current period, on average, decreases real output by 108%, and it is significant at a 1% level.

However, the coefficient of the labour force participation rate has a positive impact on real output in Nigeria. As such, a 1% increase in labour force participation rate, on average, increases real output in Nigeria by 108% in the short run. Furthermore, a unit change in the balance of trade and inflation rate in the country results in a 0.022-point and 0.13% decrease in real output in Nigeria, respectively. The result also shows that the error correction term satisfies a priori expectation as it assumes a value between 0 and 1, which is correctly signed. Its coefficient is approximately 0.0481, suggesting that the speed of adjustment from the short run back to the long run if there is disequilibrium in the model is approximately 5%.

#### Discussion of Findings

The descriptive statistics in this study revealed significant variability across key macroeconomic indicators in Nigeria over 1994–2023. The wide range in inflation (5.39%–72.84%) and real interest rates (–31.45% to 18.18%) underscores episodes of macroeconomic instability. In a related study, Nwachukwu et al. (2025) similarly found that inflation negatively impacted economic growth in Nigeria, with higher inflation reducing output through increased cost of living and investment uncertainty, affirming the high volatility observed in this dataset. In contrast, some nonlinear ARDL research suggests that inflation may have complex, asymmetric effects depending on its direction, implying that inflation dynamics are not always straightforward in growth models.

Private investment's high mean value (₦9,001.31 billion) highlights its dominant role in Nigeria's capital formation compared to public investment (₦1.63 billion). This finding agreed with Nwoko et al.'s (2024) conclusion that private sector investment significantly drives economic growth in Nigeria, especially credit to the private sector and FDI which boost expansion and job creation. Also, Awoyemi et al. (2022) argue that private sector development plays a crucial role in growth, reflecting the descriptive evidence that the private sector contributes more to capital accumulation. In contrast, studies focusing on public capital alone have found mixed effects: Adamu (2022) reported that public capital sometimes negatively affects growth due to inefficiencies, which could help explain low public investment figures here.

The unit root test results showing a mix of I(0) and I(1) variables mirror findings from Korter et al (2025), where ARDL was justified because of mixed integration orders among inflation, interest rate, and investment variables. This mix supports the methodology's robustness in handling non-stationary time series and avoiding spurious regression. The correlation analysis showed a strong positive relationship between RGDP and private investment, while the balance of trade and inflation displayed weaker relationships. This agreed with Okyere and Jilu's (2020) work which found that exports boost growth, while imports and macroeconomic instability (such as inflation) can negatively impact GDP.

The bounds test confirmed long-run cointegration ( $F = 39.4566$ ), consistent with ARDL studies in Nigeria that reliably detect long-run relationships among economic growth determinants. For instance, Sultana (2018) also reported cointegration among key

macroeconomic variables including interest rates and FDI. In the long-run estimation, this study's finding that private investment significantly boosts growth ( $\beta = 4.55$ ,  $p < 0.01$ ) is supported by Arfah (2021), who found positive effects of private sector investment on growth. Similarly, the positive effect of labour force participation aligns with broader economic theory and empirical findings linking labour engagement to productivity increases, although few recent Nigerian papers isolate this effect specifically.

Conversely, public investment was positive but not statistically significant. In contrast, Adamu's (2022) study noted that public capital sometimes exerts a negative effect due to poor utilization and inefficiencies, which may help explain its insignificant role here. Inflation's negative long-run impact on GDP agreed with Magida et al (2025), who found inflation dampens growth in Nigeria. The results reflect consistent patterns in Nigerian macroeconomic literature: private investment and labour participation are key growth drivers, while inflation and macroeconomic instability act as constraints, and public investment effects remain mixed depending on efficiency and deployment context.

## E. CONCLUSIONS AND SUGGESTIONS

This study examined the impact of private and public investment on Nigeria's economic growth using an ARDL–ECM econometric framework. The findings confirmed the existence of a long-run equilibrium relationship between real GDP and its determinants, indicating that investment dynamics and macroeconomic conditions jointly shape growth outcomes in Nigeria. The results demonstrated that private investment plays a significant and positive role in stimulating economic growth, highlighting its importance in capital formation, productivity improvement, and job creation. Labour force participation and balance of trade also contributed positively to growth, reflecting the importance of human capital utilization and external sector performance.

Conversely, inflation exerted a significant negative influence on real GDP, suggesting that macroeconomic instability undermines investment efficiency and reduces purchasing power. Public investment showed a positive but statistically insignificant effect, implying that government spending may not translate into growth when inefficiencies, misallocation, and governance challenges weaken its productivity. In the short run, adjustment dynamics indicated that deviations from long-run equilibrium were corrected gradually, confirming the stability of the growth process. The study concludes that sustainable economic growth in Nigeria depends more strongly on efficient private sector investment supported by stable macroeconomic policies. While public investment remains essential, its effectiveness depends on transparency, accountability, and strategic allocation to productive sectors such as infrastructure, education, and technology. Therefore, policies that encourage private sector participation, maintain price stability, strengthen institutional quality, and improve the efficiency of public spending are critical for achieving sustained economic growth and long-term development in Nigeria.

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