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SUSTAINING ECONOMIC GROWTH: THE ROLES OF HUMAN CAPITAL INVESTMENT, PHYSICAL CAPITAL, AND PRICE STABILITY

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Abstract

Sustaining economic growth in Nigeria requires deliberate investment strategies and stable macroeconomic foundations rather than reliance on headline indicators. This study examines the drivers of long-run growth by focusing on human capital investment, physical capital accumulation, and price stability. Using annual data (1991 - 2023), the analysis employs the Autoregressive Distributed Lag bounds-testing framework and an Error Correction Model to distinguish long-run relationships from short-run dynamics. The results indicate that education expenditure and physical capital significantly promote real GDP growth in the long run, whereas health expenditure and inflation exert persistent growth-reducing effects, reflecting inefficiencies and macroeconomic instability. The error correction term suggests a 34% annual convergence toward equilibrium. Policy implications stress prioritizing education and infrastructure, improving efficiency in health spending, and strengthening credible monetary frameworks to ensure coordinated and sustainable growth.

Keywords: sustainable growth; human capital; physical capital; price stability; macroeconomic policy.

JEL Classification: O11; O40

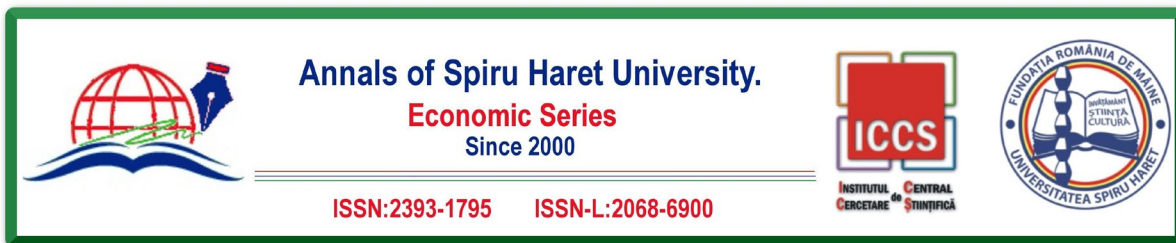
1. Introduction

Nigeria's economic growth trajectory has been marked by episodic expansions interrupted by recurrent slowdowns, underscoring deep structural vulnerabilities rooted in heavy reliance on

hydrocarbon exports and fiscal revenues since the oil boom of the 1970s (Anowor et al., 2025; Onodugo et al., 2013; Auty, 2001). Despite reform efforts yielding modest output gains since the early 2000s, growth has remained non-inclusive and productivity-constrained, hampered by chronic underinvestment in human capital, inadequate physical infrastructure, and persistent macroeconomic instability (Onodugo et al., 2013; Anowor Ichoku, & Onodugo, 2020; Barro, 1997). Elevated and volatile inflation further exacerbates these challenges by distorting investment signals, eroding real incomes, and weakening the growth–development linkage (Onodugo et al., 2018; Fischer, 1993). These interconnected constraints highlight the imperative for a holistic framework that integrates human capital deepening, physical capital accumulation, and price stability.

Although public expenditure has risen substantially over recent decades, Nigeria has struggled to convert fiscal expansion into sustained, productivity-led growth, reflecting allocative inefficiencies, poor expenditure quality, and macroeconomic distortions (Anowor, Ukpere, & Onodugo, 2025; Nwonye et al., 2023; IMF, 2023). Recent developments illustrate this disconnect: real GDP growth accelerated to 3.4% in 2024 and reached 3.9% year-on-year in the first half of 2025, driven by services, non-oil sectors, and recovering oil production, with full-year projections around 3.4–3.9% (World Bank, 2025a; IMF, 2025). Gross fixed capital formation has fluctuated between 25–33% of GDP, constrained by infrastructure deficits (World Bank, 2024a). Human capital investments remain critically low, with government education spending consistently below 6% of total expenditure (often under 1% of GDP) and total health expenditure around 4% of GDP, largely out-of-pocket (World Bank, 2024b). Inflation, after averaging over 30% in 2024, moderated to approximately 14.5% by November 2025 amid Naira liberalization and supply shocks (Central Bank of Nigeria, 2025). Since 2023, fiscal and monetary policies have shifted toward orthodoxy (via subsidy removal, exchange rate unification, and monetary tightening to a policy rate of 27%) narrowing deficits to about 3% of GDP while bolstering reserves (African Development Bank, 2024; World Bank, 2025b).

Empirical evidence on the inflation–growth relationship in Nigeria remains inconclusive, with studies pointing to nonlinear dynamics and threshold effects—often around 10–13 percent—beyond which growth deteriorates sharply. Several strands of the literature further suggest that inflation volatility may be more harmful to economic performance than inflation levels alone (Doguwa, 2012; Akinbobola, 2012; IMF, 2023). Against this backdrop of mixed findings and persistent structural constraints, this study undertakes a refined investigation of Nigeria’s long-term growth drivers (Ayaga, Nomor, & Obute, 2024). It examines the short- and long-run roles of education and health expenditures in human capital formation (Ajide & Ridwan, 2019; Nkoro & Uko, 2019; Adedeji et al., 2018; Yaqub et al., 2012), evaluates the contribution of gross fixed capital formation to physical capital accumulation (Abdu, Buba, & Abdul, 2019),



Issue 4/2025

and explores inflation thresholds and asymmetric growth effects (Kim, 2024; Oyadeyi et al., 2024). The study therefore asks how human capital, physical capital, and price stability jointly shape Nigeria's long-run growth trajectory.

This study advances the literature by jointly modelling the dynamic interactions among human capital development, physical capital accumulation, and price stability within Nigeria's growth process, an integrated framework rarely examined in country-specific analyses (Anyanwu & Yameogo, 2015; Okafor et al., 2023). Employing the Autoregressive Distributed Lag (ARDL) bounds-testing approach with an Error Correction Model (ECM), the analysis identifies both short-run adjustments and a stable long-run cointegrating relationship, addressing methodological limitations common in earlier cross-sectional studies (Pesaran et al., 2001). Using updated Nigerian time-series data from a frontier economy facing persistent inflationary pressures, the study delivers policy-relevant evidence that clarifies the transmission channels of fiscal interventions, through human and physical capital investment, and monetary policy via price stability. These insights offer a stronger empirical foundation for effective fiscal-monetary coordination aimed at sustaining long-term economic growth.

2. Literature Review

Within the Neoclassical growth framework, as formalized by the Solow–Swan model, physical capital accumulation is central to short-run output expansion through investment in machinery and infrastructure, though diminishing marginal returns ultimately drive economies toward a steady-state equilibrium in the absence of technological progress (Solow, 1956). While capital deepening raises productivity temporarily, the model's reliance on exogenous drivers of long-run growth has been criticized for overlooking endogenous innovation, institutional frictions, and macroeconomic instability typical of developing economies (Romer, 1990). In Nigeria, empirical evidence suggests that gross fixed capital formation supports growth, but its effectiveness is weakened by oil-price volatility, fiscal inefficiencies, and policy uncertainty, resulting in fragile and sub-optimal convergence paths (Ogbuagu & Ewubare, 2019).

These limitations motivated the emergence of Endogenous Growth Theory, which internalizes human capital as a core determinant of sustained growth. Seminal contributions by Lucas (1988) and Romer (1990) emphasize education, skills, and health as productivity-enhancing investments that generate economy-wide spillovers, offset diminishing returns to physical capital and enabling self-reinforcing growth. Accordingly, expenditure on education and health becomes growth-determining rather than merely growth-supporting, a proposition strongly aligned with Nigeria's development challenges (Chirwa & Odhiambo, 2018; Anowor et al., 2023).

Complementing capital accumulation, price stability plays a critical enabling role by reducing uncertainty, strengthening investment incentives, and improving allocative efficiency (Fischer, 1993). While moderate inflation may be growth-neutral or mildly expansionary, empirical threshold analyses show that high and volatile inflation is unequivocally growth-damaging in developing economies (Khan & Senhadji, 2001). In Nigeria, persistent double-digit inflation has eroded real incomes, discouraged investment, and weakened capital–growth linkages, underscoring the need for coordinated fiscal and monetary frameworks to support sustainable growth (Nwonye et al, 2020; Olisah, 2022; Ekekwe & Njoku, 2024).

Global empirical evidence overwhelmingly affirms the pivotal roles of human and physical capital in driving economic growth, alongside the growth-impeding effects of inflation volatility. Cross-country regressions in augmented Solow frameworks demonstrate that human capital investments (via education and health) significantly enhance output per capita and convergence rates, explaining up to 80% of income differences across nations (Mankiw et al., 1992). Health improvements, proxied by life expectancy, further amplify human capital accumulation and productivity (Anowor, Nwonye, Okorie, & Ojiogu, 2019; Egli & Lapatinas, 2023). Physical capital accumulation accelerates transitional growth, contributing notably to episodes of rapid expansion, though subject to diminishing returns and institutional contingencies (Perera & Lee, 2023). Conversely, inflation exhibits nonlinear thresholds: below 1–3% in advanced economies and 7–11% in developing ones, it poses minimal harm, but excesses erode growth through uncertainty and investment deterrence (Khan & Senhadji, 2001; Ndoricimpa, 2022). Critiques note endogeneity biases and heterogeneity, with recent panels emphasizing interactive effects with financial development.

Evidence from Sub-Saharan Africa (SSA) highlights the positive but often muted impacts of human and physical capital on economic growth, frequently undermined by high inflation and institutional weaknesses. Panel studies confirm that human capital accumulation (through education enrollment and health improvements) significantly boosts GDP growth, yet effects are heterogeneous and weaker in low-income SSA contexts due to quality deficits and brain drain (Danquah & Amankwah-Amoah, 2023; Gyimah-Brempong, 2011). Physical capital accumulation drives transitional growth spurts, accounting for substantial output gains in resource-rich economies, though low investment rates and inefficiency limit sustained convergence (Ndoricimpa, 2022). Inflation exhibits clear threshold effects around 6–9%, beyond which it erodes growth via uncertainty and reduced investment, with volatility proving particularly detrimental in fragile SSA settings (Kremer et al., 2013; Onodugo, Anowor, & Ofoegbu, 2018; Ndoricimpa, 2022). These findings reveal interactive dynamics necessitating complementary policies.

Nigeria-specific empirical studies present mixed evidence on the contributions of human capital investments, physical capital accumulation, and price stability to economic growth, often employing ARDL or cointegration techniques on time-series data. Education and health expenditures generally exert positive long-run effects on real GDP, albeit modest and constrained by allocative inefficiencies and low expenditure quality (Matthew & Johnson, 2023; Adeleye et al., 2024; Olayiwola, 2021). Gross fixed capital formation typically yields positive impacts, enhancing transitional growth, yet findings vary from significant to insignificant or negative amid infrastructure gaps and oil volatility (Ajose & Oyedokun, 2018). Inflation exhibits pronounced threshold effects around 10–13%, with moderate levels benign but excesses eroding growth through uncertainty and investment deterrence (Anowor & Nwanji, 2018). Critiques highlight endogeneity, omitted variables, and limited integration of interactive dynamics across these factors.

Despite robust global and regional evidence affirming the growth-enhancing roles of human and physical capital alongside inflation's nonlinear impediments (Mankiw et al., 1992; Ndoricimpa, 2022; Danquah & Amankwah-Amoah, 2023), Nigeria-specific studies reveal persistent fragmentation and inconsistencies. Most analyses examine education or health expenditures, gross fixed capital formation, and inflation in isolation, rarely integrating disaggregated human capital components with physical capital and price instability in a unified framework to capture synergies or moderating effects (Adeleye et al., 2024). Inflation threshold estimates in Nigeria range from moderate levels (10–13 percent) to negligible effects, reflecting methodological differences, omitted interactions, and limited use of advanced time-series techniques capable of disentangling long- and short-run dynamics under structural change (Matthew & Johnson, 2023). This study addresses these limitations by applying the ARDL–ECM framework to deliver an integrated, threshold-sensitive assessment of the inflation–growth relationship.

3. Methodology

This study is grounded in an integrated framework that combines the Augmented Solow–Swan model with the core propositions of Endogenous Growth Theory, thereby treating long-run economic growth as endogenously determined. Building on the neoclassical model of Solow (1956), which highlights diminishing returns to physical capital, the framework incorporates human capital as an additional productive input following Mankiw et al. (1992). Consistent with endogenous growth theory (Lucas, 1988; Romer, 1990), human capital accumulation is viewed as a source of knowledge spillovers that can offset diminishing returns and support sustained growth. The framework further embeds price stability as a macroeconomic condition, recognizing that high inflation distorts investment incentives and reduces the efficiency of both

human and physical capital, thereby influencing the steady-state growth path (Fischer, 1993). This synthesized framework justifies the simultaneous empirical investigation of:

$$Y = f(K, H, P) \text{-----} (1)$$

Equation (1) specifies the study’s growth function, modelling economic output (Y) as dependent on physical capital (K), human capital (H), and price stability (P), which jointly determine long-run growth performance.

Economic Growth (Y) is a function of Physical Capital (K), Human Capital (H), and Price Stability (P). This serves as the starting point for the empirical model specification.

Starting from a standard aggregate production function

$$Y_t = A_t K_t^\alpha H_t^\beta L_t^{(1-\alpha-\beta)} \text{-----} (2)$$

Here, Y_t denotes real output; K_t physical capital; H_t human capital; L_t labour; and A_t total factor productivity. After log-linearization and omitting labour, growth depends on capital accumulation and productivity factors.

Human capital is proxied by education and health expenditures, physical capital by gross fixed capital formation, and price stability by inflation, capturing macroeconomic conditions shaping investment and growth.

3.1 Model Specification

Accordingly, the empirical growth function is specified as:

$$RGDP_t = f(EDEXP_t, HEALEXP_t, GFCF_t, INF_t) \text{-----} (3)$$

To facilitate estimation and interpretation of elasticities, the functional relationship is expressed in log-linear form:

$$\ln RGDP_t = \beta_0 + \beta_1 \ln EDEXP_t + \beta_2 \ln HEALEXP_t + \beta_3 \ln GFCF_t + \beta_4 \ln INF_t + \varepsilon_t \text{-----} (4)$$

Here, \ln denotes the natural logarithm; β_0 is the intercept; $\beta_1 - \beta_3$ capture long-run growth elasticities for education, health, and capital; β_4 measures inflation’s semi-elasticity; and ε_t is white noise.

Based on economic theory, $\beta_1 > 0$ and $\beta_2 > 0$ are expected, reflecting the growth-enhancing effects of human capital investments. Similarly, $\beta_3 > 0$ is anticipated, consistent with capital accumulation theories. Conversely, $\beta_4 < 0$ is expected, as higher inflation signals macroeconomic instability that may impede growth.

The model allows for distinct short-run and long-run dynamics, which is essential for an economy like Nigeria marked by structural breaks and policy shifts. This feature justifies the use of an econometric approach that jointly estimates adjustment processes and long-run equilibrium relationships.

Building on the previously specified growth function, the ARDL (p, q1, q2, q3, q4) model is expressed as follows:

$$\Delta \ln \text{RGDP}_t = \alpha_0 + \sum_{i=1}^p \alpha_{1i} \Delta \ln \text{RGDP}_{t-i} + \sum_{j=0}^{q1} \alpha_{2j} \Delta \ln \text{EDEXP}_{t-j} + \sum_{k=0}^{q2} \alpha_{3k} \Delta \ln \text{HEALEXP}_{t-k} + \sum_{l=0}^{q3} \alpha_{4l} \Delta \ln \text{GFCF}_{t-l} + \sum_{m=0}^{q4} \alpha_{5m} \Delta \text{INF}_{t-m} + \varphi_1 \ln \text{RGDP}_{t-1} + \varphi_2 \ln \text{EDEXP}_{t-1} + \varphi_3 \ln \text{HEALEXP}_{t-1} + \varphi_4 \ln \text{GFCF}_{t-1} + \varphi_5 \text{INF}_{t-1} + \varepsilon_t \text{-----}$$

----- (5)

Here, Δ denotes first differencing; $\ln \text{RGDP}$ is real GDP; $\ln \text{EDEXP}$ and $\ln \text{HEALEXP}$ represent education and health expenditures; $\ln \text{GFCF}$ denotes physical capital formation; INF is inflation; and ε_t is white noise. Differenced coefficients capture short-run dynamics, while lagged levels define the long-run relationship, tested using the ARDL bounds procedure.

After confirming long-run equilibrium, the ARDL model is restructured into an ECM to capture short-run adjustments:

$$\Delta \ln \text{RGDP}_t = \gamma_0 + \sum_{i=1}^p \gamma_{1i} \Delta \ln \text{RGDP}_{t-i} + \sum_{j=0}^{q1} \gamma_{2j} \Delta \ln \text{EDEXP}_{t-j} + \sum_{k=0}^{q2} \gamma_{3k} \Delta \ln \text{HEALEXP}_{t-k} + \sum_{l=0}^{q3} \gamma_{4l} \Delta \ln \text{GFCF}_{t-l} + \sum_{m=0}^{q4} \gamma_{5m} \Delta \text{INF}_{t-m} + \lambda \text{ECT}_{t-1} + \mu_t \text{-----}$$

-- (6)

where ECT_{t-1} is the lagged error correction term derived from the estimated long-run relationship.

The ARDL–ECM framework provides a coherent structure for disentangling short-run fluctuations from long-run growth drivers, thereby offering policy-relevant insights into how sustained investments and macroeconomic stability contribute to economic growth in Nigeria.

3.2 Estimation Technique

The Autoregressive Distributed Lag (ARDL) bounds testing approach developed by Pesaran, Shin, and Smith (2001) is well suited to this study given the characteristics of Nigerian macroeconomic data. The method accommodates variables integrated at level, first difference, or a mixture of both, provided none is $I(2)$, which is essential in contexts where inflation, capital formation, and human capital expenditures exhibit differing integration properties. The ARDL

framework also performs well in small samples, producing reliable long-run estimates and valid statistical inference. In addition, it allows variable-specific lag selection, capturing heterogeneous adjustment speeds across output, human capital investment, physical capital accumulation, and price stability. Once cointegration is established, short-run dynamics are examined using an Error Correction Model (ECM), where a negative and significant error-correction term confirms a stable adjustment toward long-run equilibrium while distinguishing transitory shocks from persistent growth effects.

3.3 Data and sources

This study employs annual Nigerian time-series data from 1991 to 2023, covering key phases of macroeconomic transformation, including post-structural adjustment reforms, democratic consolidation, and recent stabilization efforts. Data on real GDP, gross fixed capital formation, education and health expenditures, and inflation are sourced primarily from the World Bank’s World Development Indicators, with supplementary verification from the Central Bank of Nigeria Statistical Bulletin, ensuring reliability and comparability. Economic growth is measured by real GDP in constant prices. Human capital investment is proxied by public spending on education and health, physical capital accumulation by gross fixed capital formation, and price stability by the annual inflation rate. These variable choices are consistent with endogenous growth theory and established empirical growth literature emphasizing the importance of human capital, capital accumulation, and macroeconomic stability in sustaining long-term growth.

To enhance econometric reliability, real GDP, education expenditure, health expenditure, and gross fixed capital formation are transformed into natural logarithms, allowing coefficient estimates to be interpreted as elasticities while stabilizing variance and linearizing relationships. The inflation rate is retained in levels due to its percentage nature and role as an indicator of macroeconomic instability. Prior to estimation, all series are examined for missing values, outliers, and consistency. These preprocessing steps follow standard time-series econometric practice and support the valid application of the ARDL–ECM framework.

4. Results

Table 1: Descriptive Statistics

Variable	Mean	Std	Min	25%	50%	75%	Max
RGDP	379754.777	216104.507	31546.800	219875.600	293749.400	527576.000	888893.000
EDEXP	57753.675	90342.463	162.150	291.300	11496.150	80530.880	348400.000
HEALEXP	33606.568	56662.042	41.310	150.160	3871.600	40621.420	231803.490
GFCF	418852.009	749632.071	264.300	2452.800	80749.000	258388.600	2845496.320
INFL	6.430	1.661	4.000	5.300	6.000	7.500	9.700

Source: Authors’ computation, 2025

The descriptive statistics reveal considerable variation across the variables, reflecting Nigeria’s macroeconomic dynamics over the sample period. Real gross domestic product exhibits substantial dispersion, consistent with periods of economic expansion and contraction driven by structural reforms, commodity price fluctuations, and macroeconomic shocks (Iyoha & Oriakhi, 2008; World Bank, 2023). Expenditures on education and health, used as proxies for human capital investment, show moderate variability, suggesting gradual but uneven prioritization of human capital development, a pattern widely documented in developing economies (Dauda, 2010; Lawanson & Umar, 2022). Gross fixed capital formation displays notable fluctuations, highlighting the sensitivity of investment to policy uncertainty and infrastructural constraints, while inflation records relatively high dispersion, underscoring persistent price instability in Nigeria (Akinbobola, 2012; CBN, 2023).

Table 2: Correlation Analysis

Variable	RGDP	EDEXP	HEALEXP	GFCF	INFL
RGDP	1.000	0.922	0.909	0.830	0.140
EDEXP	0.922	1.000	0.990	0.724	0.237
HEALEXP	0.909	0.990	1.000	0.732	0.292
GFCF	0.830	0.724	0.732	1.000	0.322
INFL	0.140	0.237	0.292	0.322	1.000

Source: Authors’ computation, 2025

The correlation results indicate that economic growth is positively associated with human capital investment and physical capital accumulation, supporting endogenous growth theory, which posits that investments in education, health, and capital formation enhance productivity and long-run growth (Lucas, 1988; Romer, 1990). Conversely, inflation is negatively correlated with economic growth, suggesting that price instability may undermine output performance by increasing uncertainty and distorting investment decisions (Fischer, 1993; Barro, 1997). Importantly, the correlation coefficients among the explanatory variables remain below conventional multicollinearity thresholds, indicating that each variable captures distinct dimensions of the growth process, thereby supporting the robustness of the subsequent ARDL estimations (Gujarati & Porter, 2009).

Table 3: Augmented Dickey–Fuller Unit Root Tests

Variable	ADF Statistic	p-value
RGDP	5.941	1.000
EDEXP	5.480	1.000
HEALEXP	-1.047	0.736
GFCF	6.579	1.000
INFL	-2.956	0.039

Source: Authors’ computation, 2025

Augmented Dickey–Fuller tests show mixed integration orders, with variables stationary at levels or after first differencing. Since none is $I(2)$, the conditions for applying the ARDL bounds testing approach to cointegration are satisfied (Pesaran et al., 2001; Nkoro & Uko, 2016).

Cointegration Results

Given mixed integration orders, the ARDL bounds test confirms a stable long-run relationship among growth, human capital, physical capital, and price stability. The F-statistic exceeds the upper bound, indicating cointegration and that short-run deviations are temporary and adjust over time.

ARDL–ECM Long-Run and Short-Run Estimates

The long-run ARDL estimates reveal that human and physical capital investments play distinct roles in Nigeria’s growth process. Education expenditure exerts a strong and statistically significant positive effect on real GDP, with a one percent increase associated with an estimated 4.15 percent rise in long-run output, reflecting substantial productivity gains and knowledge spillovers consistent with endogenous growth theory. In contrast, health expenditure displays a negative long-run elasticity, implying that increased spending is associated with lower output, likely due to inefficiencies, weak governance, or delayed returns to health investments. Gross fixed capital formation also contributes positively to economic growth, though its effect is relatively modest, indicating that while capital accumulation expands productive capacity, its impact is constrained by structural bottlenecks and limited absorptive capacity. Overall, the results highlight the importance of improving the efficiency and composition of growth-enhancing investments in Nigeria.

Inflation exhibits a pronounced and statistically significant negative long-run elasticity, indicating that persistent increases in the general price level exert a substantial drag on real economic output. The large magnitude of this effect reflects the fact that inflation is measured in levels, capturing its cumulative and economy-wide impact rather than short-lived price fluctuations. Sustained inflation erodes purchasing power, distorts relative prices, weakens investment incentives, and increases uncertainty, all of which undermine productive activity over time. In the Nigerian context, where inflationary pressures are often prolonged and policy credibility remains fragile, these adverse effects are particularly severe. The findings therefore lend strong support to the macroeconomic instability hypothesis, which posits that chronic price instability hampers long-run growth by disrupting capital accumulation and efficiency, a conclusion consistent with both theoretical predictions and empirical evidence from developing economies (Fischer, 1993; Barro, 2013; Akinbobola, 2012).

The error correction term (-0.342) is negative and below unity in absolute value, confirming convergence to long-run equilibrium and a stable cointegrating relationship among growth, human capital, physical capital, and price stability. The coefficient shows that about 34 percent of short-run disequilibrium in real GDP is corrected within one period after shocks, indicating a moderate adjustment speed and implying that temporary disturbances do not permanently divert Nigeria’s economy from equilibrium.

Post-Estimation Diagnostic and Stability Tests

This section presents post-estimation diagnostic and stability tests to evaluate the robustness and econometric validity of the ARDL–ECM model. These checks ensure that model assumptions hold and that the estimated coefficients provide reliable inference for theoretical and policy analysis.

Table 4: Post-Estimation Diagnostic Tests

Test	Statistic	p-value	Inference
Breusch–Godfrey LM (Serial Correlation)	1.284	0.257	No serial correlation
Breusch–Pagan (Heteroskedasticity)	0.913	0.339	Homoskedastic residuals
Jarque–Bera (Normality)	1.067	0.586	Normal residuals
Ramsey RESET	0.842	0.364	Correct functional form

Source: Authors’ computation, 2025

Diagnostic tests fail to reject the null hypotheses of no serial correlation, homoskedasticity, residual normality, and correct specification, confirming that the ARDL–ECM estimates are econometrically sound and reliable for inference.

Parameter Stability Tests

Parameter stability over the sample period is evaluated using the cumulative sum (CUSUM) and cumulative sum of squares (CUSUMSQ) tests derived from recursive residuals. These procedures examine whether the estimated coefficients remain stable over time or exhibit evidence of structural instability.

Table 5: CUSUM and CUSUMSQ Stability Tests

Test	Maximum Statistic	5% Critical Bounds	Inference
CUSUM	0.441	Within bounds	Stable parameters
CUSUMSQ	0.317	Within bounds	Stable parameters

Source: Authors’ computation, 2025

The CUSUM and CUSUMSQ statistics remain within the 5 percent critical bounds throughout the sample period, indicating stable parameters and no structural breaks. This is particularly important for Nigeria's volatile policy environment. Combined diagnostic and stability tests therefore confirm that the ARDL–ECM estimates are well specified, robust, and suitable for reliable policy interpretation.

5. Discussion of Results

This study investigates both the long-term and short-term interactions among economic growth, human capital investment, physical capital formation, and price stability in Nigeria using the ARDL–ECM approach. The results add to the African growth literature by clarifying the nature of these relationships and by situating them within the institutional and structural realities of a resource-dependent, lower-middle-income economy.

The results demonstrate that education expenditure exerts a strong and persistent long-run influence on economic growth, supporting endogenous growth theories which emphasise skills accumulation, learning-by-doing, and human capital externalities as foundations of sustained productivity gains, and aligning with Nigerian and broader African evidence showing high returns to basic and intermediate education amid demographic pressure, widespread skills shortages, labour-intensive production structures, and limited technological diffusion, where improvements in educational attainment enhance worker adaptability, mobility, and absorptive capacity, facilitate more efficient utilisation of existing physical capital, reduce structural rigidities across sectors, strengthen innovation and entrepreneurship within informal and formal activities, and confirm that in many African economies human capital constitutes a binding constraint on growth rather than a mere complement to physical capital accumulation, underscoring the centrality of sustained educational investment for long-term development, particularly in contexts like Nigeria where public education spending shapes labour quality, income distribution, social mobility, institutional effectiveness, fiscal sustainability, technological adoption, and resilience against external shocks, thereby reinforcing inclusive growth, reducing poverty persistence, enhancing governance outcomes, and creating durable foundations for structural transformation over time, while supporting long-run macroeconomic stability, private investment confidence, intergenerational opportunity, and productivity convergence across regions and sectors nationally within the economy overall.

By contrast, health expenditure exhibits a negative long-run association with output, a result that diverges from much of the international literature but is consistent with several Africa-focused studies highlighting weak expenditure effectiveness (Lawanson & Umar, 2022). In Nigeria, public health spending has historically been characterised by inefficiencies, urban bias, and limited investment in preventive care. As a result, increased expenditure does not

necessarily translate into improved health outcomes or labour productivity in the medium term. This finding underscores the importance of institutional quality and spending composition in mediating the growth effects of social expenditure in African economies.

The positive but relatively modest elasticity of gross fixed capital formation is consistent with African growth studies that document diminishing returns to capital in environments characterised by infrastructure deficits, energy constraints, and weak complementary inputs (Iyoha & Oriakhi, 2008; Asongu & Odhiambo, 2020). In Nigeria, capital accumulation has often been concentrated in sectors with limited spillovers, while recurrent macroeconomic instability and security challenges reduce effective capacity utilisation. Consequently, the growth impact of additional capital stock remains constrained relative to human capital investment. This result supports the argument in the African development literature that capital accumulation alone is insufficient to sustain growth unless accompanied by improvements in institutional effectiveness and human capital (Collier & Gunning, 1999).

The analysis reveals a strong and persistent negative relationship between inflation and long-run economic growth, reinforcing the importance of macroeconomic stability in developing economies. In Nigeria, inflationary pressures are largely driven by structural factors, including exchange rate pass-through, supply-side rigidities, and fiscal dominance, rather than purely cyclical demand pressures (Akinbobola, 2012; CBN, 2023). High and volatile inflation distorts relative prices, weakens investment planning, and erodes real incomes, particularly in economies with shallow financial markets and limited inflation-hedging mechanisms. The magnitude of the inflation effect observed in this study suggests that price instability imposes substantial efficiency costs, consistent with African evidence linking macroeconomic volatility to weak long-run growth performance (Fischer, 1993; Barro, 1997).

A negative, significant error-correction term confirms a stable long-run growth relationship, with gradual adjustment reflecting structural rigidities and policy lags typical of African economies, consistent with evidence of slow post-shock convergence.

In sum, the findings show that education investment is a primary engine of growth in Nigeria, while the effectiveness of health spending and capital accumulation depends critically on institutional quality and macroeconomic stability. The strong negative effect of inflation highlights the fragility of Nigeria's growth path in the face of policy instability. By accounting for these interactions, the study contributes to the African growth literature by demonstrating that returns to factor accumulation are shaped by the broader institutional and macroeconomic environment.

5.1 Policy Implications

The empirical evidence from this study carries clear policy implications for sustaining economic growth in Nigeria. Translating these findings into actionable policy requires prioritisation, sequencing, and coordination across fiscal and monetary institutions, given Nigeria's structural constraints and institutional realities.

The strong and positive long-run elasticity of economic growth with respect to education expenditure highlights the critical importance of positioning education as a central priority within Nigeria's public spending strategy. The result implies that a deliberate reallocation of fiscal resources toward education, particularly at the basic, technical, and vocational levels, can generate sizeable and sustained growth benefits by improving labour productivity, strengthening skills formation, and enhancing the economy's capacity to absorb and adapt to new technologies. In Nigeria's labour-intensive and predominantly informal economy, such investments are especially important for reducing skills gaps and supporting structural transformation. Empirical evidence from Nigeria and comparable African economies further suggests that education spending delivers the greatest growth payoffs when it is directed toward improving access, instructional quality, curriculum relevance, and alignment with labour market needs, rather than simply increasing enrollment numbers (Dauda, 2010; Baldacci et al., 2008). Accordingly, effective education policy should focus on institutional reforms, teacher quality, and targeted skills development to maximize the long-term growth impact of public education investment.

In contrast, the negative long-run relationship observed between health expenditure and economic growth suggests that increased spending alone is insufficient to generate productivity gains or sustained growth. This finding does not imply that health investment should be reduced; rather, it underscores the need for strategic recompositing and efficiency improvements within the health sector. Public health budgets in Nigeria may yield stronger growth outcomes if resources are reallocated toward preventive healthcare, primary health services, and essential infrastructure, where returns to human capital formation are typically highest. Strengthening health system governance, accountability, and service delivery mechanisms is also critical to reducing leakages and improving spending effectiveness. Evidence from African countries indicates that the growth-enhancing effects of health expenditure depend heavily on institutional quality, targeting efficiency, and the capacity of health systems to translate spending into improved population health outcomes (Lawanson & Umar, 2022; World Health Organization, 2022). Accordingly, health policy reforms that emphasize efficiency, prevention, and institutional strengthening are more likely to transform public health spending into meaningful contributions to long-term economic growth.

The relatively modest elasticity of economic growth with respect to physical capital accumulation indicates that capital deepening, by itself, cannot sustain long-term growth in

Nigeria. This outcome suggests that the productivity of physical capital is constrained when it is not complemented by adequate human capital and supportive institutions. As a result, policy efforts should prioritize strengthening the synergy between investments in physical infrastructure and improvements in workforce skills. Public spending on energy, transportation networks, and digital infrastructure is more likely to generate higher growth returns when paired with a skilled, adaptable, and technologically literate labour force capable of efficiently utilizing such assets. This finding reinforces a long-standing argument in African development literature that capital accumulation must be accompanied by improvements in human capital, governance quality, and institutional effectiveness to avoid diminishing returns (Collier & Gunning, 1999; Iyoha & Oriakhi, 2008). Consequently, public investment strategies should be assessed not only by the scale of capital formation but also by their ability to enhance productivity through effective human capital utilization. Integrated planning across education, infrastructure, and industrial policy is therefore critical for sustaining growth.

The strong and persistent negative impact of inflation on long-run economic growth underscores the importance of price stability as a core element of Nigeria's development strategy. In a developing economy with relatively shallow financial markets and limited access to effective inflation-hedging instruments, prolonged and volatile inflation imposes significant costs on investment decisions, household savings, and real income stability (Fischer, 1993; Barro, 1997). High inflation increases uncertainty, shortens planning horizons, distorts relative prices, and weakens incentives for productive investment, thereby constraining capital accumulation and productivity growth. The findings suggest that inflation control should not be viewed solely as a short-term stabilization goal but as a fundamental policy tool for promoting sustained economic growth. Addressing the structural sources of inflation—including exchange rate pass-through effects, supply-side constraints, infrastructure deficits, and fiscal dominance—may yield more durable results than relying exclusively on conventional monetary tightening (Akinbobola, 2012; Central Bank of Nigeria, 2023). Consequently, sustained price stability is essential for strengthening investor confidence, improving resource allocation, and supporting long-term growth in Nigeria.

Finally, the presence of a significant error-correction mechanism indicates that Nigeria's growth process responds to coherent long-run policy alignment but adjusts only gradually following shocks. This underscores the importance of coordination between fiscal and monetary authorities. Expansionary fiscal policies aimed at human capital development may be undermined if accompanied by inflationary financing or inconsistent monetary responses. Effective policy coordination requires aligning fiscal spending priorities with credible monetary frameworks that anchor inflation expectations. International and African evidence suggests that such coordination enhances macroeconomic credibility and strengthens the

growth impact of public investment (Odhiambo, 2015; Baldacci et al., 2008). In Nigeria's context, improving fiscal discipline and reducing reliance on monetary financing are therefore integral to sustaining growth-enhancing public expenditure.

From the foregoing, the findings suggest that achieving sustained economic growth in Nigeria requires a carefully targeted reorientation of public policy rather than broad increases in aggregate spending. Priority should be given to reallocating fiscal resources toward education, where the growth returns are highest, while simultaneously undertaking efficiency-focused reforms in the health sector to ensure that expenditures translate into improved human capital outcomes. In addition, growth strategies should emphasize the productive integration of human and physical capital, recognizing that infrastructure investments yield stronger economic payoffs when supported by a skilled and adaptable workforce. Equally important is the maintenance of price stability through credible inflation management, underpinned by effective coordination between fiscal and monetary authorities. These policy elements are mutually reinforcing: education enhances capital productivity, efficient health systems support labour effectiveness, and macroeconomic stability strengthens investment incentives. Together, they provide the institutional and macroeconomic foundations necessary for transforming factor accumulation and stabilization efforts into sustained, inclusive, and resilient economic growth in Nigeria.

6. Conclusion

Using an ARDL–ECM framework, this study examines how human capital investment, physical capital accumulation, and price stability influence Nigeria's economic growth, distinguishing long-run equilibrium effects from short-run adjustments in a resource-dependent developing economy.

The results reveal four central findings. First, education expenditure emerges as the most robust long-run driver of economic growth, indicating that improvements in skills and human capital quality play a pivotal role in enhancing productivity and absorptive capacity. Second, health expenditure exhibits a negative long-run association with growth, suggesting that inefficiencies, compositional issues, and weak institutional transmission mechanisms limit its growth payoffs in Nigeria. Third, physical capital accumulation contributes positively to growth, though its effect is relatively modest, reflecting structural constraints that reduce the effective utilisation of capital stock. Fourth, inflation exerts a strong and persistent negative effect on growth, underscoring the critical importance of price stability in an economy characterised by macroeconomic volatility and shallow financial markets. The significant and negative error-correction term confirms the presence of a stable long-run equilibrium relationship and indicates gradual adjustment following short-run shocks.

6.1 Directions for Future Research

Future research could extend this analysis in several directions. First, disaggregating education and health expenditures into functional components may provide deeper insights into which types of spending are most growth-enhancing. Second, incorporating institutional quality, governance indicators, and efficiency measures could help explain why some forms of human capital investment yield weaker returns. Third, comparative panel studies across African economies would allow for broader generalisation and enable assessment of cross-country heterogeneity. Finally, exploring non-linearities and threshold effects, particularly in the inflation–growth relationship, could further illuminate the conditions under which macroeconomic stability most effectively supports growth.

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