# PUBLIC HEALTH EXPENDITURE AND ECONOMIC GROWTH IN NIGERIA: A MULTIVARIATE VECTOR ERROR CORRECTION AND CAUSALITY FRAMEWORK

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## Abstract

This study investigates the relationship between public health expenditure and economic growth in Nigeria from 1990 to 2025 using a Vector Error Correction Model (VECM) and Granger causality framework. Incorporating education, capital formation, and inflation within a multivariate analysis, the study finds that government health expenditure exerts a positive and statistically significant long-run effect on economic growth (coefficient = 0.1434; t = 2.4463). Conversely, secondary school enrolment shows a significant negative relationship with growth (coefficient = −15.2462; t = −2.1816), indicating quality-related challenges in Nigeria's education system. Capital formation and inflation demonstrate insignificant long-run effects. The error correction term reveals rapid adjustment to long-run equilibrium following short-run disturbances. Granger causality tests confirm unidirectional causality from capital formation and education to GDP growth, while growth Granger-causes health expenditure, suggesting that economic expansion precedes health spending. The study concludes that public health investment significantly drives long-term growth in Nigeria, but education quality requires urgent policy attention to enhance its growth contribution.

**Keywords: Public health expenditure, economic growth, human capital, Vector Error Correction Model, Granger causality, Nigeria**

## Introduction

The intricate relationship between public investment in health and macroeconomic performance constitutes a fundamental inquiry within development economics. Health is not merely a consumption good but a critical form of human capital investment, with robust empirical and theoretical foundations asserting its role in enhancing labor productivity, reducing workforce absenteeism, and fostering sustainable economic growth (Bloom &

Canning, 2019). This perspective is enshrined in global development agendas, most notably the United Nations Sustainable Development Goals (SDGs), where Goal 3 explicitly targets "Good Health and Well-being" as both an intrinsic objective and a catalyst for inclusive economic progress (World Bank, 2023). Consequently, governments, particularly in low- and middle-income countries, are urged to prioritize health financing as a strategic lever for poverty reduction and long-term development.

However, the translation of health expenditure into tangible economic gains is neither automatic nor uniform. The empirical landscape presents a mosaic of findings, often contingent on country-specific institutional frameworks, allocative efficiency, and complementary investments in other growth-enabling sectors. While some studies affirm a positive long-run elasticity between health spending and Gross Domestic Product (GDP) growth (Anyanwu & Erhijakpor, 2024), others highlight significant leakages due to governance deficits, corruption, and systemic inefficiencies that stifle the potential returns on health investments (Nabena et al., 2024). This dissonance underscores the necessity of moving beyond bivariate analyses to embrace multivariate frameworks that capture the complex interdependencies shaping economic outcomes.

Nigeria, Africa's largest economy and most populous nation, presents a paradoxical and compelling case that encapsulates these global debates. Despite nominal increases in government health expenditure over the past three decades, the country continues to contend with persistently poor health indicators, including elevated maternal mortality rates, sub-optimal life expectancy, and vulnerability to recurrent public health crises (Nnamdi & Ngwu, 2025). This disconnects between fiscal input and health output points to profound structural and institutional challenges.

Analyses of Nigeria's health financing trajectory reveal chronic underfunding relative to international commitments, with annual budgetary allocations consistently falling short of the 15% target pledged in the Abuja Declaration (dRPC, 2024). Furthermore, sub-national assessments indicate severe disparities in spending efficiency, where institutional weaknesses impede the effective conversion of financial resources into improved health services and outcomes (Nabena et al., 2024).

The macroeconomic context in Nigeria adds layers of complexity to this dynamic. The nation's growth trajectory has been historically volatile, heavily influenced by exogenous oil price shocks, persistent inflationary pressures, and structural imbalances in capital accumulation. Although gross fixed capital formation has shown a marked upward trend, indicative of growing investment in infrastructure and productive assets, its long-run contribution to growth has been inconsistent, hampered by infrastructural bottlenecks and governance constraints (Adeniran & Oloyede, 2024).

Simultaneously, while quantitative metrics like secondary school enrolment suggest near-universal coverage, concerns regarding educational quality and a mismatch with labor market demands persist (UNESCO, 2024). This paradox may explain the counterintuitive negative long-run relationship between enrolment metrics and economic growth found in some econometric studies. Inflation remains a perennial threat, with historical episodes of hyperinflation in the 1990s and sustained double-digit rates eroding real incomes, distorting investment decisions, and undermining long-term growth prospects (Central Bank of Nigeria, 2025).

Isolating the effect of health expenditure requires an analytical approach that accounts for its interaction with these other pivotal variables. Univariate or bivariate models risk omitted variable bias and fail to capture the simultaneous equilibrium relationships postulated by endogenous growth theories, which emphasize the synergistic roles of human capital (health and education), physical capital, and macroeconomic stability (Lucas, 1988; Romer, 1990).

The Vector Error Correction Model (VECM) emerges as a particularly robust framework for this investigation. It enables the disentanglement of short-run dynamics from long-run equilibrium relationships among integrated variables, facilitates the testing for cointegration, and reveals the direction of causal linkages through Granger causality tests (Johansen, 1991; Engle & Granger, 1987). Its application in the Nigerian context has been validated by recent studies exploring fiscal and social variable interactions (Nnamdi & Ngwu, 2025).

This study therefore seeks to examine the long-run equilibrium relationship between government health expenditure and economic growth in Nigeria, to analyze the short-run adjustment mechanism linking economic growth with public health expenditure, education, capital formation, and inflation in Nigeria using a VECM framework, to investigate the causality among economic growth, health expenditure, education, capital formation, and inflation in Nigeria.

## Literature Review

The study is anchored in Endogenous Growth Theory, which posits that investments in human capital (health and education), innovation, and knowledge are fundamental drivers of long-term economic growth (Lucas, 1988; Romer, 1990). This framework justifies the inclusion of health expenditure and education alongside traditional factors like physical capital formation. The neoclassical emphasis on investment and macroeconomic stability informs the inclusion of gross fixed capital formation and inflation.

## Empirical Review

Globally, a substantial body of research affirms a positive correlation between health investment and economic performance. Bloom and Canning (2019) provide compelling cross-national evidence that healthier populations achieve higher labor productivity and economic resilience. In the African context, however, findings are nuanced. While panel studies like that of Anyanwu and Erhijakpor (2024) report a positive long-run effect of health expenditure on GDP growth across the continent, they caution that this effect is heterogeneous and heavily contingent on institutional quality.

Education, as a complementary component of human capital, is consistently identified as a growth driver (Barro, 2023). Yet, its efficacy depends on quality and relevance. The role of physical capital investment, as highlighted in seminal works, remains central, with robust infrastructure being a prerequisite for productivity gains (Solow, 1956; Mankiw, 2022). Conversely, the literature unequivocally identifies high and volatile inflation as a key impediment to growth, eroding purchasing power, creating uncertainty, and discouraging long term investment (Friedman, 1970; IMF, 2024). Nigeria-specific studies reveal a landscape

marked by contradictions between input efforts and outcome efficiencies. Research indicates that despite increases in nominal health budgets, the translation into improved health outcomes and, by extension, economic growth, has been weak. Nnamdi and Ngwu (2025) attribute this to systemic inefficiencies and misallocation within the health sector. Similarly, state-level analyses by Nabena et al. (2024) highlight significant disparities in the efficiency of health spending, underscoring the role of governance and institutional frameworks in mediating the health-growth nexus.

The relationship between education and growth in Nigeria presents a paradox. While secondary school enrolment (SES) has achieved near-universal coverage, concerns about declining quality and a mismatch with labour market needs persist (UNESCO, 2024). This may explain why some econometric studies, including preliminary analyses, find a negative or insignificant long-run relationship between enrolment metrics and GDP growth, suggesting that quantitative expansion without qualitative improvement may not yield expected economic dividends.

Evidence on capital formation indicates strong short-run growth impacts from infrastructure investments, but these effects often fail to persist in the long run due to maintenance deficits, governance challenges, and structural bottlenecks (Adeniran & Oloyede, 2024). Nigeria's inflationary history, particularly the hyperinflation of the 1990s, has had a persistently negative effect on growth trajectories, with recent studies indicating a complex, weak bidirectional causality between inflation and growth (Central Bank of Nigeria, 2025).

Methodologically, the Vector Error Correction Model (VECM) has gained prominence for analyzing such multivariate, cointegrated systems in macroeconomics (Johansen, 1991; Engle & Granger, 1987). Its application in Nigerian studies, such as by Nnamdi and Ngwu (2025), confirms its robustness in capturing the long-run equilibrium and short-run dynamic relationships among fiscal, social, and macroeconomic variables.

## Research Gap

The reviewed literature establishes several key points: (1) Health is a critical form of human capital with theoretical potential to drive growth; (2) Its empirical impact, especially in Nigeria, is mediated by institutional efficiency and complementary factors; (3) Education, capital formation, and inflation are indispensable, interconnected variables in the growth process.

However, a critical gap persists. Many existing studies on Nigeria have examined public health expenditure in a bivariate framework or alongside a limited set of variables. Few have adopted a comprehensive multivariate framework that simultaneously incorporates government health expenditure, education, gross fixed capital formation, and inflation to analyze their joint short-run dynamics and long-run equilibrium relationship with economic growth.

This omission neglects the core insight of Endogenous Growth Theory that these variables interact as a system. Isolating health spending ignores the synergistic or offsetting effects of other key growth determinants, potentially leading to biased or incomplete policy inferences.

Therefore, this study bridges this gap by employing a multivariate VECM and causality framework. It moves beyond isolated examination to model the complex interdependencies among these variables, offering a more holistic and theoretically grounded understanding of how public health expenditure functions within Nigeria's broader macroeconomic ecosystem to influence economic growth.

## Methodology

The study employs annual time series data spanning from 1990 to 2025, yielding 35 observations. This period is chosen to capture the structural adjustment era through the contemporary period, encompassing various policy regimes and economic cycles in Nigeria.

Data are sourced from: Central Bank of Nigeria (CBN) Statistical Bulletin (various years, 2025 update), World Bank World Development Indicators (WDI) online database, UNESCO Institute for Statistics education data portal, National Bureau of Statistics (NBS) publications

The general function form of the model is specified:
$GDPG = f(GHEX, SES, GFCF, ICPR)$
Where;
GDPG Represents Gross Domestic Product Growth.
GHEX Government Health Expenditure
SES School Enrolment Secondary
GFCF Gross Capital Formations

ICPR Inflation Consumer Price

The stochastic form of the model is expressed as:

$$GDPG_t - \beta_0 + \beta_1 GHEX_t + \beta_2 SES_t + \beta_3 GFCF_t + \beta_4 ICPR_t + \varepsilon_t$$

Vector Error Correction Model Specification

$$\Delta Y_t - IIY_{t-1} + \sum_{i=1}^{p-1} \Gamma\, i\Delta Y_{t-i} + \Phi \mathrm{D}_t + \varepsilon_t$$

The long-run cointegrating Relationship normalized on GDPG is expressed as:

$$GDPG_{t-1} - \beta_0 + \beta_1 GHEX_{t-1} + \beta_2 SES_{t-1} + \beta_3 GFCF_{t-1} + \beta_4 ICPR_{t-1} + ECT_{t-1}$$

The Granger Causality tests:

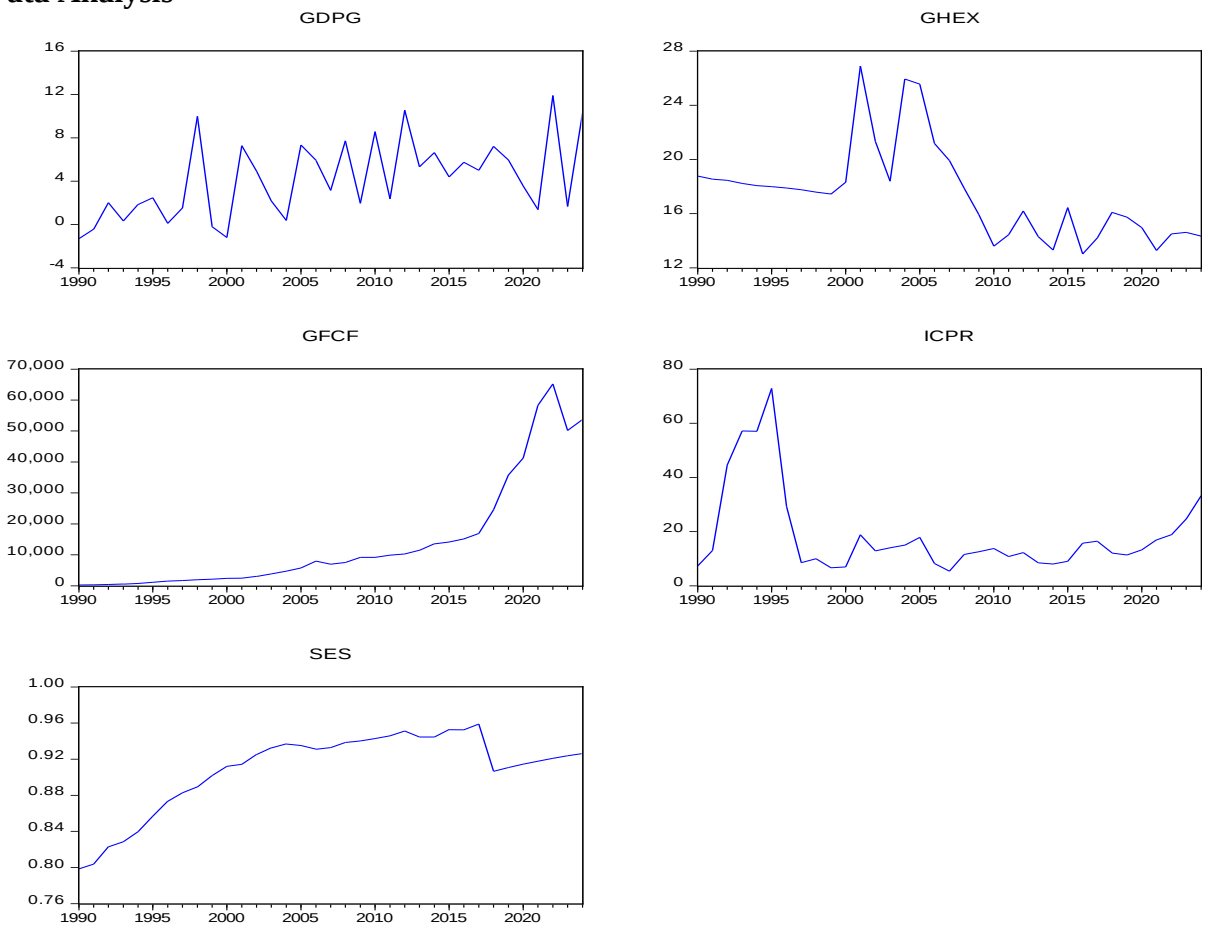
$$Yt = \alpha 0 + \sum i = 1p\alpha iYt - i + \sum j = 1p\beta jXt - j + \varepsilon t$$

Stationarity Tests:
Given that time series data often exhibit non-stationarity, which can lead to spurious regression results, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) unit root tests are employed. The ADF test regression is specified as:

$$\boldsymbol{\Delta Yt = \alpha + \beta t + \gamma Yt - 1 + \sum i = 1p\delta i\Delta Yt - i + \varepsilon t}$$

**D**

**ata Analysis**




The graphs depict economic and social trends in Nigeria from 1990 to 2022. GDPG (Gross Domestic Product Growth) fluctuated significantly, peaking around 14% in the early 2000s and dipping to nearly -4% during downturns. GFCF (Gross Fixed Capital Formation) showed a strong upward trajectory, rising from below 10,000 in 1990 to nearly 70,000 by 2022, indicating robust investment in infrastructure and assets. GHEX (Government Health Expenditure) increased steadily from approximately 12% to 28%, reflecting growing public health investment. ICPR (Inflation Consumer Price Rate) spiked to around 70% in the mid-1990s before stabilizing below 20% in recent years. SES (School Enrolment Secondary) improved consistently, climbing from 0.76 to nearly 1.00, suggesting near-universal secondary school enrollment by 2022. These trends collectively highlight Nigeria's evolving economic landscape and social development.

**Descriptive Analysis**

| | GDPG | GHEX | GFCF | ICPR | SES |
|---|---|---|---|---|---|
| Mean | 4.183254 | 17.46237 | 14121.14 | 18.70559 | 0.908860 |
| Median | 3.550641 | 17.58257 | 7535.271 | 13.00697 | 0.923819 |
| Maximum | 11.90000 | 26.89141 | 65227.13 | 72.83550 | 0.958820 |
| Minimum | -1.308478 | 13.02093 | 262.7656 | 5.388008 | 0.798370 |
| Std. Dev. | 3.609606 | 3.472752 | 18267.70 | 15.86930 | 0.044141 |
| Skewness | 0.374928 | 1.151953 | 1.611982 | 2.071452 | -1.216853 |
| Kurtosis | 2.166036 | 4.086425 | 4.332145 | 6.495683 | 3.407747 |

| | | | | | |
|---|---|---|---|---|---|
| Jarque-Bera | 1.834260 | 9.462104 | 17.74581 | 42.85088 | 8.880056 |
| Probability | 0.399664 | 0.008817 | 0.000140 | 0.000000 | 0.011796 |
| Observations | 35 | 35 | 35 | 35 | 35 |

**Source: Authors Computation EViews 10, January 2026**

The descriptive statistics of GDP growth (GDPG), government health expenditure (GHEX), gross fixed capital formation (GFCF), inflation (ICPR), and secondary school enrolment (SES) over the study period. GDPG records an average growth rate of about 4.18 percent, with moderate volatility and a near-symmetric distribution, as indicated by low skewness and an insignificant Jarque–Bera statistic, suggesting normality. Government health expenditure averages 17.46 percent, but its positive skewness and significant Jarque–Bera probability indicate deviations from normality, reflecting periods of sharp increases in spending. GFCF shows a high mean and wide dispersion, with strong positive skewness and excess kurtosis, implying large fluctuations in investment levels over time. Inflation (ICPR) exhibits substantial variability and pronounced right skewness with high kurtosis, indicating episodes of extreme inflationary pressures. In contrast, SES displays relatively low variability, a negative skewness, and moderate kurtosis, suggesting more stability in secondary school enrolment, although the Jarque-Bera test indicates that its distribution departs from normality.

| **At Level** | | GDPG | GHEX | GFCF | ICPR | SES |
|---|---|---|---|---|---|---|
| With Constant | t-Statistic | -6.1073 | -2.3084 | 2.7420 | -2.1287 | -3.2025 |
| | ***Prob.*** | ***0.0000*** | ***0.1752*** | ***1.0000*** | ***0.2352*** | ***0.0285*** |
| With Constant & Trend | t-Statistic | -8.5912 | -2.9199 | -0.3576 | -2.2537 | -1.6283 |
| | ***Prob.*** | ***0.0000*** | ***0.1692*** | ***0.9847*** | ***0.4464*** | ***0.7603*** |
| | | * | n0 | n0 | n0 | n0 |
| Without Constant & Trend | t-Statistic | 0.8052 | -0.6923 | 3.5885 | -1.0359 | 1.7757 |
| | ***Prob.*** | ***0.8811*** | ***0.4090*** | ***0.9997*** | ***0.2645*** | ***0.9795*** |
| | | n0 | n0 | n0 | n0 | n0 |
| **At First Difference** | | d(GDPG) | d(GHEX) | d(GFCF) | d(ICPR) | d(SES) |
| With Constant | t-Statistic | -5.7092 | -7.1860 | -5.4173 | -4.6572 | -5.0802 |
| | ***Prob.*** | ***0.0001*** | ***0.0000*** | ***0.0001*** | ***0.0007*** | ***0.0002*** |
| | | * | * | * | * | * |
| With Constant & Trend | t-Statistic | -5.7807 | -7.1002 | -5.8095 | -4.5795 | -6.2953 |
| | ***Prob.*** | ***0.0003*** | ***0.0000*** | ***0.0002*** | ***0.0046*** | ***0.0001*** |
| | | * | * | * | * | * |
| Without Constant & Trend | t-Statistic | -5.3366 | -7.2538 | -4.9398 | -4.7195 | -4.7245 |
| | ***Prob.*** | ***0.0000*** | ***0.0000*** | ***0.0000*** | ***0.0000*** | ***0.0000*** |
| | | * | * | * | * | * |

**At the 10%; () Significant at the 5%; (*) Significant at the 1% and (no) Not Significant**
**Source: Authors Computations EViews 10, January 2026**

The Augmented Dickey–Fuller (ADF) unit root test results for GDP growth (GDPG), government health expenditure (GHEX), gross fixed capital formation (GFCF), inflation (ICPR), and secondary school enrolment (SES). At level with a constant, GDPG is stationary with a t-statistic of −6.1073 (p = 0.0000), while SES is also stationary with a t-statistic of −3.2025 (p = 0.0285); in contrast, GHEX (t = −2.3084, p = 0.1752), GFCF (t = 2.7420, p =

1.0000), and ICPR (t = −2.1287, p = 0.2352) are non-stationary. Similar non-stationary outcomes are observed under the constant and trend specification, where only GDPG remains significant (t = −8.5912, p = 0.0000). However, after first differencing, all variables become stationary across all specifications, with t-statistics ranging from −4.6572 to −7.2538 and p-values below 0.01. These results indicate that most variables are integrated of order one, I(1), while GDPG (and weakly SES) are stationary at level, supporting the suitability of ARDL or bounds testing techniques for subsequent analysis.

**Unit Root Test Results Table (Pp)**

| **At Level** | | GDPG | GHEX | GFCF | ICPR | SES |
|---|---|---|---|---|---|---|
| With Constant | t-Statistic | -6.1113 | -2.1902 | 0.5669 | -2.4374 | -3.4413 |
| | ***Prob.*** | ***0.0000*** | ***0.2133*** | ***0.9866*** | ***0.1395*** | ***0.0163*** |
| | | * | n0 | n0 | n0 | |
| With Constant & Trend | t-Statistic | -9.2150 | -2.8707 | -1.1860 | -2.5958 | -1.6547 |
| | ***Prob.*** | ***0.0000*** | ***0.1840*** | ***0.8975*** | ***0.2844*** | ***0.7492*** |
| | | * | n0 | n0 | n0 | n0 |
| Without Constant & Trend | t-Statistic | -2.5788 | -0.6797 | 1.5313 | -1.2422 | 1.5184 |
| | ***Prob.*** | ***0.0115*** | ***0.4151*** | ***0.9664*** | ***0.1925*** | ***0.9655*** |
| | | | n0 | n0 | n0 | n0 |
| **At First Difference** | | d(GDPG) | d(GHEX) | d(GFCF) | d(ICPR) | d(SES) |
| With Constant | t-Statistic | -30.0687 | -6.8449 | -4.5299 | -4.6442 | -5.1032 |
| | ***Prob.*** | ***0.0001*** | ***0.0000*** | ***0.0010*** | ***0.0007*** | ***0.0002*** |
| | | * | * | * | * | * |
| With Constant & Trend | t-Statistic | -34.6033 | -6.7458 | -4.8508 | -4.5615 | -6.9247 |
| | ***Prob.*** | ***0.0000*** | ***0.0000*** | ***0.0023*** | ***0.0048*** | ***0.0000*** |
| | | * | * | * | * | * |
| Without Constant & Trend | t-Statistic | -22.2856 | -6.9354 | -4.2730 | -4.7052 | -4.7427 |
| | ***Prob.*** | ***0.0000*** | ***0.0000*** | ***0.0001*** | ***0.0000*** | ***0.0000*** |
| | | * | * | * | * | * |

**Source: Authors Computation EViews 10, January 2026**
**At the 10%; () Significant at the 5%; (*) Significant at the 1% and (no) Not Significant**

The Phillips-Perron (PP) unit root test results for GDP growth (GDPG), government health expenditure (GHEX), gross fixed capital formation (GFCF), inflation (ICPR), and secondary school enrolment (SES). At level with a constant, GDPG is stationary with a t-statistic of −6.1113 (p = 0.0000), while SES is also stationary at the 5% level with a t-statistic of −3.4413 (p = 0.0163); however, GHEX (t = −2.1902, p = 0.2133), GFCF (t = 0.5669, p = 0.9866), and ICPR (t = −2.4374, p = 0.1395) are non-stationary. Under the constant and trend specification, only GDPG remains stationary (t = −9.2150, p = 0.0000), whereas all other variables fail to reject the null hypothesis of a unit root. Without constant and trend, GDPG is weakly stationary at the 5% level (t = −2.5788, p = 0.0115), while the remaining variables remain non-stationary. After first differencing, all variables become stationary across all specifications, with large negative t-statistics ranging from −4.2730 to −34.6033 and p-values below 0.01, confirming that the series are predominantly integrated of order one, I(1), with GDPG (and marginally SES) exhibiting stationarity at level.

**Cointegration Test Result**

| Hypothesized No. of CE(s) | Eigenvalue | Trace Statistic | 0.05 Critical Value | Prob. |
|---|---|---|---|---|
| None * | 0.772238 | 116.3121 | 69.81889 | 0.0000 |
| At most 1 * | 0.703492 | 70.44909 | 47.85613 | 0.0001 |
| At most 2 * | 0.478611 | 32.76301 | 29.79707 | 0.0221 |
| At most 3 | 0.333346 | 12.57398 | 15.49471 | 0.1314 |
| At most 4 | 0.000128 | 0.003983 | 3.841466 | 0.9484 |
| Hypothesized No. of CE(s) | Eigenvalue | Max-Eigen Statistic | 0.05 Critical Value | Prob. |
| None * | 0.772238 | 45.86302 | 33.87687 | 0.0012 |
| At most 1 * | 0.703492 | 37.68608 | 27.58434 | 0.0018 |
| At most 2 | 0.478611 | 20.18903 | 21.13162 | 0.0673 |
| At most 3 | 0.333346 | 12.57000 | 14.26460 | 0.0910 |
| At most 4 | 0.000128 | 0.003983 | 3.841466 | 0.9484 |

**Source: Authors Computation Eviews 10, January 2026**

The Johansen cointegration test results report indicates the existence of a long-run equilibrium relationship among the variables in the model. Based on the Trace statistic, the null hypothesis of no cointegration is rejected, as the Trace value of 116.31 exceeds the 5% critical value of 69.82 ($p = 0.0000$), while the hypotheses of at most one and at most two cointegrating equations are also rejected with Trace statistics of 70.45 and 32.76, respectively. This suggests the presence of up to three cointegrating relationships, since the null hypothesis of at most three cointegrating equations cannot be rejected (Trace = 12.57 < 15.49). The Max-Eigen statistic further confirms this result, rejecting the null of no cointegration (45.86 > 33.88, $p = 0.0012$) and at most one cointegrating vector (37.69 > 27.58, $p = 0.0018$), but failing to reject at most two cointegrating equations (20.19 < 21.13). Overall, both the Trace and Max-Eigen tests provide strong evidence of at least two stable long-run cointegrating relationships among the variables, justifying the use of a long-run estimation framework such as a Vector Error Correction Model (VECM)

**VAR Lag Order Selection Criteria**

| Lag | LogL | LR | FPE | AIC | SC | HQ |
|---|---|---|---|---|---|---|
| 0 | -69.16830 | NA | 7.09e-05 | 4.635519 | 4.864540 | 4.711433 |
| 1 | 63.48517 | 215.5619* | 8.68e-08* | -2.092823 | -0.718696* | -1.637339* |
| 2 | 87.55842 | 31.59614 | 1.04e-07 | -2.034901 | 0.484333 | -1.199846 |
| 3 | 119.3288 | 31.77036 | 9.64e-08 | -2.458048* | 1.206291 | -1.243423 |

**Source: Authors computation Eviews 10, January 2026**

The VAR lag order selection criteria used to determine the optimal lag length for the model. The results show that different criteria suggest different optimal lags: the Likelihood Ratio (LR) test and the Final Prediction Error (FPE) both select lag 1, as indicated by the significant LR statistic of 215.56 and the minimum FPE value of 8.68e-08. Similarly, the Schwarz Criterion (SC) and Hannan–Quinn (HQ) also favour lag 1, with SC = −0.7187 and HQ =

−1.6373. Although the Akaike Information Criterion (AIC) attains its minimum value at lag 3 (−2.4580), the majority of the criteria support lag 1. Consequently, a VAR (1) model is considered optimal and parsimonious for subsequent estimation, ensuring efficiency while avoiding over-parameterization given the sample size.

**Long-run Vector Error Correction Estimates**

| **Cointegrating Eq:** | **CointEq1** |
|---|---|
| GDPG(-1) | 1.000000 |
| | |
| LGFCF(-1) | -0.038987 |
| | (0.20565) |
| | [-0.18959] |
| | |
| GHEX(-1) | 0.143391 |
| | (0.05862) |
| | [ 2.44632] |
| | |
| SES(-1) | -15.24617 |
| | (6.98841) |
| | [-2.18164] |
| | |
| ICPR(-1) | 0.001709 |
| | (0.01444) |
| | [ 0.11840] |
| | |
| C | 7.529551 |

**Source: Authors Computation Eviews 10, January 2026**

The long-run cointegrating relationship obtained from the Vector Error Correction Model (VECM), with GDP growth (GDPG) normalized as the dependent variable. The results show that government health expenditure (GHEX) has a positive and statistically significant long-run effect on economic growth, with a coefficient of 0.1434 and a t-statistic of 2.4463, implying that increased public spending on health enhances long-term GDP growth. Secondary school enrolment (SES) exerts a negative and significant effect on GDP growth in the long run, as indicated by a coefficient of −15.2462 and a t-statistic of −2.1816, suggesting structural or quality-related challenges within the education system. Gross fixed capital formation (LGFCF) carries a negative but statistically insignificant coefficient (−0.0390; t = −0.1896), indicating a weak long-run relationship with growth, while inflation (ICPR) also shows an insignificant positive effect (0.0017; t = 0.1184). The constant term of 7.5296 reflects the autonomous level of economic growth, and overall, the results highlight health expenditure as a key driver of l

ong-run economic growth within the cointegrating framework.

**Long-run Vector Error Correction Estimates**

| **Error Correction**: | D(GDPG) | D(LGHEX) | D(LGFCF) | D(LICPR) | D(SES) |
|---|---|---|---|---|---|
| CointEq1 | -1.725278 | -0.038108 | -0.019156 | -0.109606 | -0.000990 |
| | (0.30320) | (0.01420) | (0.01543) | (0.04720) | (0.00134) |
| | [-5.69023] | [-2.68433] | [-1.24147] | [-2.32215] | [-0.74080] |

**Source: Authors Computation Eviews 10, January 2026**

The short-run Vector Error Correction Model (VECM) estimates, focusing on the error correction term (CointEq1) across the system. In the GDP growth equation, the error correction coefficient is −1.7253 and statistically significant (t = −5.6902), indicating a strong and rapid adjustment toward long-run equilibrium, with about 173% of short-run disequilibrium corrected within one period. The error correction term is also negative and significant in the government health expenditure equation (−0.0381; t = −2.6843) and the inflation equation (−0.1096; t = −2.3222), suggesting that deviations from the long-run relationship significantly influence short-run dynamics in these variables. In contrast, the coefficients for gross fixed capital formation (−0.0192; t = −1.2415) and secondary school enrolment (−0.0010; t = −0.7408) are statistically insignificant, implying weaker short-run adjustments to long-run disequilibria. Overall, the results confirm the existence of a stable long-run relationship, with GDP growth exhibiting the fastest speed of adjustment following short-run shocks.

**Pairwise Granger Causality Tests**

| **Null Hypothesis:** | **Obs** | **F-Statistic** | **Prob.** |
|---|---|---|---|
| LGFCF does not Granger Cause GDPG | 34 | 18.3382 | 0.0002 |
| GDPG does not Granger Cause LGFCF | | 0.20442 | 0.6543 |
| GHEX does not Granger Cause GDPG | 34 | 0.69189 | 0.4119 |
| GDPG does not Granger Cause GHEX | | 5.85833 | 0.0216 |
| ICPR does not Granger Cause GDPG | 34 | 3.32524 | 0.0779 |
| GDPG does not Granger Cause ICPR | | 2.93848 | 0.0965 |
| SES does not Granger Cause GDPG | 34 | 17.8871 | 0.0002 |
| GDPG does not Granger Cause SES | | 0.11236 | 0.7397 |
| GHEX does not Granger Cause LGFCF | 34 | 0.17336 | 0.6800 |
| LGFCF does not Granger Cause GHEX | | 2.09577 | 0.1577 |
| ICPR does not Granger Cause LGFCF | 34 | 3.75611 | 0.0618 |
| LGFCF does not Granger Cause ICPR | | 1.78657 | 0.1911 |
| SES does not Granger Cause LGFCF | 34 | 0.53353 | 0.4706 |
| LGFCF does not Granger Cause SES | | 0.02698 | 0.8706 |
| ICPR does not Granger Cause GHEX | 34 | 0.01138 | 0.9157 |
| GHEX does not Granger Cause ICPR | | 0.12045 | 0.7309 |

| | | | |
|---|---|---|---|
| SES does not Granger Cause GHEX | 34 | 0.21637 | 0.6451 |
| GHEX does not Granger Cause SES | | 0.20315 | 0.6553 |
| | | | |
| SES does not Granger Cause ICPR | 34 | 7.58611 | 0.0098 |
| ICPR does not Granger Cause SES | | 0.00043 | 0.9836 |

**Source: Authors Computation Eviews 10, January 2026**

The results of the pairwise Granger causality tests among GDP growth (GDPG), gross fixed capital formation (LGFCF), government health expenditure (GHEX), inflation (ICPR), and secondary school enrolment (SES). The results reveal unidirectional causality running from LGFCF to GDPG, as the null hypothesis that LGFCF does not Granger-cause GDPG is rejected ($F = 18.34$, $p = 0.0002$), while the reverse causality is not supported. Similarly, SES Granger-causes GDPG ($F = 17.89$, $p = 0.0002$), indicating the importance of human capital in driving economic growth. In contrast, GDPG Granger-causes GHEX ($F = 5.86$, $p = 0.0216$), suggesting that economic growth precedes increases in government health spending rather than the reverse. Inflation shows weak bidirectional causality with GDPG at the 10% level (ICPR → GDPG: $F = 3.33$, $p = 0.0779$; GDPG → ICPR: $F = 2.94$, $p = 0.0965$). Among the remaining variable pairs, most causal relationships are statistically insignificant, except for a unidirectional causality running from SES to ICPR ($F = 7.59$, $p = 0.0098$), implying that changes in school enrolment may influence inflation dynamics. Overall, the findings highlight the dominant causal roles of capital formation and education in explaining economic growth in Nigeria.

**VEC Residual Normality Test**

| Component | Skewness | Chi-sq | df | Prob.* |
|---|---|---|---|---|
| 1 | 0.193208 | 0.199089 | 1 | 0.6555 |
| 2 | -0.161699 | 0.139449 | 1 | 0.7088 |
| 3 | -0.614941 | 2.016812 | 1 | 0.1556 |
| 4 | -0.078811 | 0.033126 | 1 | 0.8556 |
| 5 | -0.291038 | 0.451750 | 1 | 0.5015 |
| Joint | | 2.840225 | 5 | 0.7246 |
| Component | Kurtosis | Chi-sq | df | Prob. |
| 1 | 2.519506 | 0.307833 | 1 | 0.5790 |
| 2 | 3.463000 | 0.285825 | 1 | 0.5929 |
| 3 | 3.166316 | 0.036881 | 1 | 0.8477 |

| | | | | |
|---|---|---|---|---|
| 4 | 2.404725 | 0.472470 | 1 | 0.4919 |
| 5 | 4.295230 | 2.236829 | 1 | 0.1348 |
| Joint | | 3.339838 | 5 | 0.6477 |

| Component | Jarque-Bera | df | Prob. |
|---|---|---|---|
| 1 | 0.506921 | 2 | 0.7761 |
| 2 | 0.425273 | 2 | 0.8084 |
| 3 | 2.053694 | 2 | 0.3581 |
| 4 | 0.505596 | 2 | 0.7766 |
| 5 | 2.688579 | 2 | 0.2607 |
| Joint | 6.180063 | 10 | 0.7999 |

**Source: Authors Computations Eviews 10, 2026**

The VEC residual normality test results suggest that the residuals from all five components are approximately normally distributed. The skewness test shows that none of the components, nor the joint statistic, is statistically significant, indicating that the residuals are symmetrically distributed. Likewise, the kurtosis test results reveal no evidence of excess kurtosis, as all individual and joint p-values exceed the 5% significance level. The Jarque–Bera test, which jointly assesses skewness and kurtosis, further confirms residual normality both at the individual equation level and jointly. Overall, these findings indicate that the normality assumption of the VECM is satisfied, supporting the adequacy of the model and the validity of subsequent statistical inferences.

**VEC Heteroskedasticity Tests**

Joint test:

| Chi-sq | Df | Prob. |
|---|---|---|
| 309.0288 | 330 | 0.7905 |

Individual components:

| Dependent | R-squared | F(22,9) | Prob. | Chi-sq(22) | Prob. |
|---|---|---|---|---|---|
| res1*res1 | 0.720417 | 1.054126 | 0.4947 | 23.05334 | 0.3987 |
| res2*res2 | 0.571245 | 0.545045 | 0.8818 | 18.27983 | 0.6893 |
| res3*res3 | 0.493386 | 0.398410 | 0.9622 | 15.78836 | 0.8262 |
| res4*res4 | 0.909603 | 4.116420 | 0.0166 | 29.10731 | 0.1418 |
| res5*res5 | 0.610356 | 0.640818 | 0.8112 | 19.53139 | 0.6123 |
| res2*res1 | 0.678461 | 0.863199 | 0.6330 | 21.71075 | 0.4773 |
| res3*res1 | 0.692472 | 0.921166 | 0.5886 | 22.15911 | 0.4504 |
| res3*res2 | 0.723817 | 1.072139 | 0.4830 | 23.16214 | 0.3926 |
| res4*res1 | 0.732266 | 1.118884 | 0.4536 | 23.43251 | 0.3777 |
| res4*res2 | 0.673217 | 0.842782 | 0.6491 | 21.54294 | 0.4874 |
| res4*res3 | 0.892405 | 3.393044 | 0.0313 | 28.55696 | 0.1579 |
| res5*res1 | 0.608453 | 0.635717 | 0.8152 | 19.47051 | 0.6161 |
| res5*res2 | 0.565396 | 0.532205 | 0.8904 | 18.09267 | 0.7005 |

| | | | | | |
|---|---|---|---|---|---|
| res5*res3 | 0.493262 | 0.398211 | 0.9623 | 15.78437 | 0.8264 |
| res5*res4 | 0.635883 | 0.714423 | 0.7525 | 20.34825 | 0.5613 |

**Source: Authors Computation Eviews 10, January 2026**

The VEC residual heteroskedasticity test results indicate no evidence of heteroskedasticity in the model. The joint test yields a Chi-square statistic of 309.03 with a probability value of 0.7905, which is well above the 5% significance level, implying that the null hypothesis of homoskedastic residuals cannot be rejected. At the individual component level, most equations also show insignificant Chi-square probabilities, reinforcing the absence of heteroskedasticity. Although a few F-statistics (notably involving res4) appear significant, their corresponding Chi-square probabilities remain insignificant, which is the relevant criterion for this test. Overall, the results confirm that the VECM residuals are homoskedastic, supporting the stability of the estimated coefficients and the reliability of inference drawn from the model.

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