ABUAD INTERNATIONAL JOURNAL OF NATURAL AND APPLIED SCIENCES
ISSN: 2955-1021
AIJNAS Volume 5, Issue 2, 2025 pp 149-161
https://doi.org/10.53982/aijnas.2025.0502.09-j

https://journals.abuad.edu.ng/index.php/aijnas

FROM WINDFALLS TO EQUILIBRIUM: MODELING NIGERIA'S GDP GROWTH WITH AUTOREGRESSIVE DISTRIBUTED LAG(ARDL) BOUNDS TESTING (1990–2023)

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Abstract
This study investigates the short-run and long-run determinants of Nigeria's real GDP growth from 2003 to 2023, focusing on key macroeconomic variables: exchange rate, foreign direct investment (FDI), inflation, oil price, and real interest rate. Using annual time-series data and rigorous stationarity testing via Augmented Dickey–Fuller and Phillips–Perron methods, we confirm a mix of I(0) and I(1) series, validating the use of the Autoregressive Distributed Lag (ARDL) bounds-testing framework. The optimal ARDL (2,3,3,0,1) model reveals significant short-run dynamics: a 1% depreciation in the exchange rate reduces GDP growth by approximately 0.04 percentage points, while a 1% increase in lagged oil prices boosts growth by 0.14 points. Notably, a 1% rise in FDI from the previous year is associated with a 1.5-point decline in current GDP growth, suggesting adjustment frictions or absorptive constraints. The bounds test yields an F-statistic of 3.19 ($p \approx 0.07$), indicating possible cointegration at the 10% level and a tentative long-run equilibrium among the variables. Complementary Granger causality tests confirm FDI as a statistically significant short-run predictor of GDP, with oil price showing marginal influence. These findings underscore the need for exchange-rate stabilization, strategic FDI management, and economic diversification beyond oil dependence. The integrated ARDL approach offers a robust framework for policymakers seeking to harmonize short-term stabilization with long-term growth resilience in resource-dependent economies.

Keywords: Oil price; Foreign direct investment; Exchange rate

JEL Classification: C22 Time-Series Models; E44 Financial Markets and the Macroeconomy; F31 Foreign Exchange

1.0 Introduction

Nigeria's economic performance over the past three decades has been marked by volatility, driven largely by external shocks and structural imbalances. Periods of rapid expansion have often coincided with oil-price booms, while contractions have followed global downturns, currency depreciation, and capital flight. This cyclical pattern underscores the economy's vulnerability to global commodity markets, exchange-rate instability, and inconsistent foreign investment flows. Understanding the dynamic interplay between these macroeconomic variables and GDP growth is essential for designing policies that promote resilience and long-term development.

Existing literature has explored various determinants of growth in Nigeria and Sub-Saharan Africa, highlighting the roles of capital accumulation, institutional quality, and external linkages (Ajide, 2014; Ugwunna& Obi, 2023; Ivic, 2015). However, many studies rely on static models or overlook the distinction between short-run shocks and long-run equilibrium relationships. Moreover, conventional approaches such as vector autoregression (VAR) often require all variables to be stationary, limiting their applicability in real-world settings where macroeconomic series exhibit mixed integration orders.

To address these gaps, this study employs the Autoregressive Distributed Lag (ARDL) bounds-testing approach developed by Pesaran, Shin, and Smith (2001). This method accommodates both I(0) and I(1) variables, allowing for a more flexible and robust analysis of Nigeria's GDP growth determinants. Using annual data from 2003 to 2023, we examine the short-run and long-run effects of exchange rate, foreign direct investment (FDI), inflation, oil price, and real interest rate on GDP growth. Unit-root tests confirm that inflation is stationary, while exchange rate, oil price, and FDI are non-stationary, validating the ARDL framework.

The results reveal significant short-run effects: lagged oil prices positively influence GDP, while exchange-rate depreciation and past FDI inflows exert negative pressure. The bounds test suggests possible cointegration at the 10% level, indicating a tentative long-run equilibrium among the

variables. These findings have important policy implications, including the need for exchange-rate stabilization, strategic FDI management, and economic diversification beyond oil dependence.

The remainder of the paper is structured as follows: Section 2 reviews the relevant literature on macroeconomic growth drivers. Section 3 outlines the data sources, econometric methodology, and model specification. Section 4 presents the empirical results and discusses both short-run dynamics and long-run relationships. Section 5 concludes with policy recommendations aimed at fostering sustainable and inclusive growth in Nigeria.

1.1 Literature review

A robust body of scholarship has sought to explain why some economies expand steadily while others lagand what distinguishes mere output growth from deeper structural transformation. Early contributions by Solow (1956) and the physiocrats (Ivic, 2015) established social reproduction and capital-labor dynamics as the engines of growth, yet they could not account for the persistent divergences in living standards across regions. Solow's neoclassical model highlighted diminishing returns to factor accumulation, inviting the endogenous-growth literature to elevate technology and institutions as core investible inputs (Dimitrijević & Fabris, 2007; Alfaro, Chanda, Kalemli-Özcan, &Sayek, 2004).

Building on these foundations, Ivic(2015) distinguished economic growthan annual rise in GDPfrom economic development, which encompasses qualitative changes such as sectoral rebalancing, technological adoption, and institutional renewal. Ivic (2015) shows that without these structural shiftsexemplified by industrial capacity expansion and service-sector maturation, rising output per capita cannot translate into broader welfare gains. Ivic (2015) underscores capital deepening (the rising capital-to-worker ratio) and technological progress as twin drivers of sustainable growth, while cautioning that productivity gains require continual investment in R&D and human capital.

In the Nigerian context, Ajide (2014) applies a growth-augmented regression framework to data spanning 1980–2010, revealing that disaggregated dimensions of economic freedom and physical capital formation shape the country's expansion trajectory. Ajide (2014) confirm that gross fixed capital formation and life expectancy materially boost GDP, whereas excessive openness and weak property-rights enforcement can drag on output. Crucially, Ajide (2014) finds that "size of government" and "trade freedom": two components of the Fraser Economic Freedom Indexexert significant, opposing effects, foreshadowing the need for nuanced, policy-sensitive interventions rather than one-size-fits-all reforms.

Extending this inquiry to Sub-Saharan Africa (SSA) more broadly, Ugwunna and Obi (2023) analyze panel data for 23 middle-income SSA countries over 1996–2020. Their fixed-effects estimates attribute robust per-capita growth to gross fixed capital formation, foreign direct investment, and even population growthunderscoring scale economies when demographic gains are matched by productive investment. By contrast, reliance on foreign aid and excessive exchange-rate volatility emerge as growth impediments. These findings dovetail with earlier regional studies (Chang & Mendy, 2012; Ndambiri et al., 2012), which similarly highlight capital accumulation, trade openness, and institutional stability as essential for SSA's ascent.

Across Nigeria and its SSA neighbors, then, three themes coalesce. First, physical capital deepening remains indispensable but no longer sufficient: once basic infrastructure is in place, efficiency-enhancing investmentsin technology, human capital, and governancebecome the binding constraint (Ristić, Komazec, Savić, & Petković, 2006; Mijiyawa, 2013). Second, institutional qualityfrom property-rights protection to predictable policy regimesplays a decisive role in channeling investment into growth-enhancing activities (de Haan, Lundström, & Sturm, 2006; Ghazanchyan& Stotsky, 2013). Third, external linkageswhether via FDI (Ajide, 2014; Ugwunna& Obi, 2023), trade openness (Sala-i-Martin, Doppelhofer, & Miller, 2004), or global commodity cyclescan amplify domestic efforts but also expose economies to volatility if not undergirded by resilient macroeconomic frameworks (Boldeau& Constantinescu, 2015; Patel, 2018).

The literature points to a multifaceted growth process: capital accumulation and labor expansion must be complemented by innovation, human-capital development, and strong institutions if countries are to convert rising GDP into lasting economic development. The present study builds on this tradition by integrating disaggregated measures of economic freedom with FDI and other standard growth determinants, thereby offering a more finely–tuned roadmap for policymakers seeking to igniteand sustainAfrica's economic transformation.

2.0 Materials and methods

This section presents the methodological framework adopted to investigate the short-run and long-run determinants of economic growth in Nigeria from 2003 to 2023. The approach integrates rigorous time-series econometric techniques, including unit-root testing, ARDL model specification, cointegration analysis, and diagnostic validation, to ensure robust and interpretable results.

2.1 Data and variable construction

The study utilizes annual time-series data spanning 2003 to 2023 (n = 21), sourced from reputable institutions namely, World Bank and Macrotrends to ensure consistency and reliability. Links to the data on GDP; Inflation Rate; Exchange Rate, Brent Crude Oil Price ; Real Interest Rate and Foreign Direct Investment include https://databank.worldbank.org/indicator/NY.GDP.MKTP.KD.ZG/1ff4a498/Popular-Indicators;

https://www.macrotrends.net/global-metrics/countries/nga/nigeria/inflation-rate-cpi; https://data.worldbank.org/indicator/PA.NUS.FCRF?end=2024&locations=NG&page=1&start=1960&view=chart; https://www.macrotrends.net/2480/brent-crude-oil-prices-10-year-daily-chart; https://data.worldbank.org/indicator/FR.INR.RINR?end=2023&locations=NG&start=1970&view=chart; and https://www.macrotrends.net/global-metrics/countries/nga/nigeria/foreign-direct-investment

The dependent variable is Nigeria's real GDP growth rate, while the explanatory variables include:

- Exchange rate (₦ per US$) – Macrotrends
- Net FDI inflows (% of GDP) – World Bank
- Inflation rate (annual CPI change) – World Bank
- Brent crude oil price (US$/barrel) – World Bank
- Real interest rate (lending rate minus inflation) – Macrotrends

To ensure comparability and econometric validity, each series is transformed appropriately. Variables such as exchange rate, oil price, and FDI are included in both levels and first differences to capture dynamic effects. Inflation and real interest rate, which exhibit stationary behavior, are retained in levels.

2.2 Stationarity and integration testing

Before model estimation, it is essential to determine the time-series properties of each variable. We apply two complementary unit-root tests:

Augmented Dickey–Fuller (ADF) test, which accounts for autocorrelation through lagged differencing.

Phillips–Perron (PP) test, which corrects for serial correlation and heteroskedasticity nonparametrically.

The decision rule is as follows:

- Variables stationary in levels (I(0)) are included directly.
- Variables non-stationary in levels but stationary in first differences (I(1)) are modeled using both levels and differences.
- No variable exhibits second-order integration (I(2)), validating the use of the ARDL bounds-testing framework.

2.3 ARDL model specification and estimation

The Autoregressive Distributed-Lag (ARDL) model is selected for its flexibility in handling mixed integration orders and its ability to distinguish between short-run dynamics and long-run equilibrium relationships. Lag selection is guided by the Akaike Information Criterion (AIC) and Schwarz Bayesian Criterion (SBC), resulting in the optimal specification:

- ARDL(2,3,3,0,1)
  - GDP lags = 2
  - Exchange rate lags = 3
  - FDI lags = 3
  - Inflation lags = 0
  - Oil price lags = 1
  - Interest rate lags = 1

Estimation is performed using Ordinary Least Squares (OLS). Short-run coefficients on differenced terms capture immediate effects, while level coefficients are used to derive long-run multipliers conditional on cointegration.

Bounds testing for cointegration

To assess the existence of a long-run equilibrium relationship among the variables, we apply the bounds-testing procedure developed by Pesaran, Shin, and Smith (2001). The test evaluates the joint significance of lagged level variables in the ARDL model:

- Null hypothesis: No cointegration

Long-run elasticities

When cointegration is present, long-run elasticities are computed using the formula:

$$\beta_j^{LR} = \frac{Coefficient\ of\ X_j}{1 - \sum Lagged\ GDP\ coefficients}$$

Given the near-unit sum of GDP lags (~0.99), long-run estimates are sensitive and require cautious interpretation. A more stable error-correction model is recommended for precise long-run inference.

2.4 Diagnostic and robustness checks

To validate the model's reliability, we conduct the following diagnostic tests:

- Serial correlation: Breusch–Godfrey LM test
- Heteroskedasticity: Breusch–Pagan test
- Normality of residuals: Jarque–Bera test
- Parameter stability: CUSUM and CUSUMSQ plots

2.5 Granger causality test

To complement the ARDL analysis and further investigate short-run predictive relationships among macroeconomic variables and GDP growth, we apply the Granger causality test. This test assesses whether lagged values of an independent variable contain statistically significant information that helps forecast the dependent variable in this case, Nigeria's real GDP growth rate.

Model specification

For each macroeconomic variable (Exchange Rate, FDI, Inflation, Oil Price, and Interest Rate), we estimate two nested models:

- **Model 1 (Unrestricted)**:

$$GDP_t = \alpha_0 + \sum_{i=1}^{P} \alpha_i GDP_{t-1} + \sum_{j-1}^{\alpha} \beta_j X_{t-j} + \varepsilon_t$$

where (X) is the macroeconomic variable being tested.

- **Model 2 (Restricted)**:

$$GDP_t = \alpha_0 + \sum_{i=1}^{P} \alpha_i GDP_{t-1} + \varepsilon_t$$

The null hypothesis is:

$H_0: \beta_1 = \beta_2 = \ldots = \beta_3 = 0$

i.e., the lagged values of (X) do not Granger-cause GDP.

Estimation procedure

- We use two lags (p = q = 2) for all variables, consistent with the ARDL lag structure and sample size constraints.
- The test performs an F-test comparing the restricted and unrestricted models.
- A statistically significant F-statistic ($p < 0.05$) indicates rejection of the null hypothesis, implying that the variable Granger-causes GDP.

Interpretation

- A significant result implies short-run predictive power of the tested variable over GDP growth.
- Non-significance suggests that the variable does not independently improve GDP forecasts based on its past values.
- The test does not imply true causality in the philosophical sense, but rather temporal precedence and predictive relevance.

This procedure allows us to identify which macroeconomic indicators serve as leading signals for GDP fluctuations, thereby enriching the short-run dynamics captured in the ARDL framework.

3.0 Discussion

3.1 Stylized facts about Nigerian macro series

3.1.1 Nigeria's aggregate GDP from 1990 through 2023

The Nigeria's aggregate GDP from 1990 through 2023 series averages about 4.25, ranges from –2.04 to 15.33, and is slightly right-skewed (the maximum lies well above the median Table 1).

Table 1: Descriptive Summary of ts_GDP Nigeria

Statistic	Value
Minimum	–2.035
1st Quartile	1.994
Median	4.213
Mean	4.246
3rd Quartile	6.553
Maximum	15.329

Source: Authors

Figure 1 shows three distinct phases in Nigeria's aggregate GDP from 1990 through 2023:

Modest growth (1990–1999)

Through the 1990s, GDP rises only gradually from near zero on the chart to about 5 units by 1999. This reflects a largely oil-dependent economy with limited production and weak investment.

Oil-fueled boom (2000–2014)

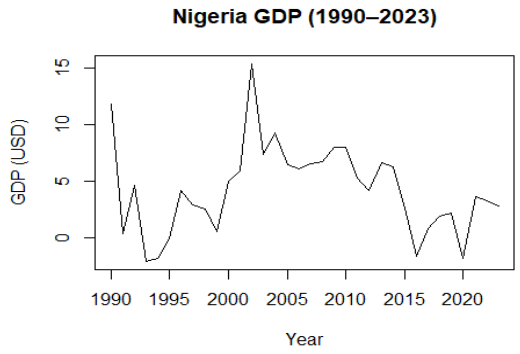
Beginning around 2000, GDP soars from roughly 5 up to a peak near 15 units by 2014. Higher global oil prices, deregulation, and modest economic reforms supercharged output. Annual growth rates in this period regularly exceeded 7 percent.

Post-boom decline and slow recovery (2015–2023)

In 2015–2016, the curve plunges sharply as the oil price crashes and foreign-exchange shortages bite, marking Nigeria's worst contraction in decades. From 2017 onward, GDP edges back upward but only to about 7–8 units by 2023, well below the 2014 high. This muted rebound underscores ongoing vulnerabilities: dependence on oil, foreign-exchange volatility, and structural bottlenecks.

Economic implications

Nigeria's fortunes over these 30 years track the oil cycle. When prices and investment surged, output ballooned; when the oil sector slumped, the nation fell into recession and has yet to regain its pre-2015 level of economic activity.



Source: Authors

Figure 1: Nigeria's aggregate GDP from 1990 through 2023

In Table 2, The Augmented Dickey–Fuller test fails to reject a unit root (p=0.72), implying non-stationarity, whereas the Phillips–Perron test does reject (p=0.018), suggesting stationarity after correcting for serial correlation. These mixed outcomes indicate the series sits near the border of stationarity and may require differencing or additional tests (e.g., KPSS) before further time-series modeling. Both tests start from the same null hypothesis that the series has a unit root (i.e. is non-stationary) but they implement different corrections for serial correlation and heteroskedasticity. The ADF builds an AR(p) model and tests whether its autoregressive coefficient equals 1, replacing higher-order autocorrelation by lagged differences. The PP uses a non-parametric correction to the test statistic's variance and can be more powerful when there's complex autocorrelation or heteroskedasticity. When they conflict, it usually means the series lies near the boundary between stationary and non-stationary. In plain terms, the ADF says our GDP series still "wanders" over time, it does not revert cleanly around a fixed mean.

Table 2: Unit-root test results for Nigeria's aggregate GDP from 1990 through 2023

Test	Statistic	Lag/Truncation	p-Value	Verdict
ADF	–1.622	3	0.7194	Non-stationary
PP	–21.964	3	0.0183	Stationary

Source: Authors

3.1.2 Nigeria's exchange-rate from 1990 through 2023

Figure 2 showing Nigeria's exchange-rate depreciation (indexed to 100% at 1990) through 2023 and reveals three phases:

1990–2000

Stability under 10% : The naira traded within a narrow band, depreciating only modestly as oil revenues and FX controls held it in check.

2000–2019

Gradual but persistent depreciation: By 2005 it hit roughly 20%, climbed to 25% by 2010, then drifted toward 35% by the late 2010s. Each uptick aligns with falling oil prices (mid-2000s, 2014-15) and mounting external pressures.

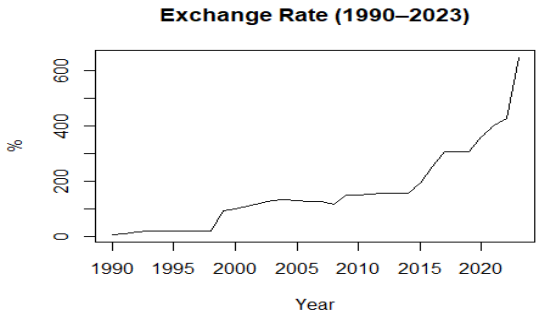
2020–2023

Sharp acceleration: Post-pandemic FX shortages and import-bill pressures drove depreciation from ~35% in 2020 to nearly 60% by 2023, the steepest slide in the entire series.

Economic implications

Chronic currency weakening raises import costs, fuels inflation, and erodes purchasing power. The post-2020 spike underscores acute FX-market stress and highlights the need for deeper diversification of foreign-exchange sources and stronger reserve buffers. When a country's currency steadily loses value like this, it means every year Nigerians need more naira to buy the same basket of imports: things like fuel, medicine, machinery or even some food staples. From 1990 to 2000, the naira was roughly stable, so imports weren't getting much more expensive. After 2000, though, it gradually weakened: by 2019 you needed around a third more naira for the same dollar amount than you did back in 1990. That slowly drove up the cost of imported goods, nudging up inflation year by year. Since 2020, the naira's fall has been much steeper nearly doubling the cost of a dollar in just three years. This jump makes everyday items imported from abroad suddenly much pricier. Families feel it in higher grocery bills, motorists see it at the pump, and manufacturers pay more for imported parts. A weaker naira raises the price of anything bought in dollars. It feeds directly into higher consumer prices, squeezing household budgets. Businesses that rely on imported inputs see their costs skyrocket, which can slow production and force layoffs.

Stabilizing the naira by boosting exports, diversifying away from oil, and building foreign-exchange reserves would help keep everyday prices in check and protect people's purchasing power.



Source: Authors

Figure 2: Nigeria's exchange-rate from 1990 through 2023

3.1.3Nigeria's real interest rate from 1990 through 2023

Figure 3 shows how Nigeria's real interest rate (the inflation-adjusted cost of borrowing) swung dramatically from 1990 through 2023:

Early 1990s

Deeply Negative Rates (around –30%): High inflation far outpaced lending rates, savers lost purchasing power, and banks effectively charged negative real rates.

Mid-1990s to Early-2000s

Wild Swings: As policy rates rose and inflation briefly eased, real rates flipped positivesometimes into double digits, then fell back into negative territory. This chaos reflects both erratic monetary tightening and volatile inflation.

Late-2000s Peak

Double-Digit Positives: Around 2008–2010, real rates briefly topped +15% as the central bank aggressively hiked rates amid tame inflation. That rewarded savers but squeezed borrowers.

2010s Onward

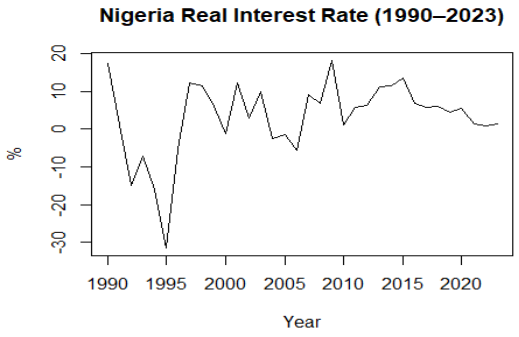
Gradual Decline and Stabilization: After peaking, real rates trended downward with smaller peaks and troughs. By 2023, they hovered near zero, meaning nominal rates barely exceeded inflation.

Economic implications

Thus, over 30 years, Nigerian borrowers and savers faced wild, unpredictable costs. Negative real rates wiped out savers; sudden hikes punished borrowers. In recent years, policy has smoothed out, but real rates near zero mean little incentive for saving and modest relief for borrowers. More consistent monetary policy and better inflation control would help restore trust in banks and stabilize the economy.

Here's what those wild swings in real interest rates mean for everyday Nigerians and the economy as a whole, in plain terms: When real rates plunged well below zero, your bank savings were actually losing purchasing power. People pulled money out of formal banks and hoarded cash, making banks less able to lend. When rates suddenly jumped into the high teens, borrowing became prohibitively expensive. Businesses put expansion plans on hold and households postponed big purchases like homes or cars. By the end of the period, with real rates hovering around zero, there's little reward for saving (you barely beat inflation) and only modest relief for borrowers.

Taken together, this roller-coaster discourages both saving and long-term investment. Stabilizing real rates, keeping them modestly positive and predictable would restore confidence in banks, channel more funds into productive loans, and help lift economic activity.



Source: Authors

Figure 3: Nigeria's real interest rate from 1990 through 2023

3.1.4 Nigeria's annual inflation rate from 1990 through 2023

Figure 4 depicts Nigeria's year-over-year inflation from 1990 through 2023:

From 1990 to about 2014

Inflation hovered roughly between –5% and +5%, showing periods of mild deflation (negative rates) when prices fell, alternating with small positive inflation. In 2015, inflation plunged catastrophically to nearly 40% indicating a massive drop in the price level, likely driven by an acute cash crunch and collapsing demand. Immediately after, inflation rocketed above +20% by around 2020. This swing reflects severe price volatility essentially, a crash then a hyper-shock in household costs. After peaking, inflation then fell back toward zero by 2023, suggesting some normalization but still extreme uncertainty compared to earlier decades.

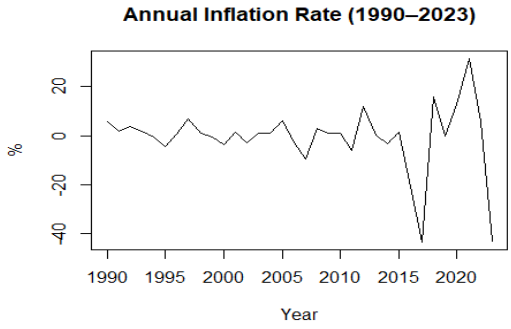
Economic implications

Plainly, Nigerians saw stable, modest price changes for two decades, then endured a price collapse and a rapid surge in cost of living within a few years. That roller-coaster devastates budgets: first goods become suddenly cheap but scarce, then skyrocket in price, wiping out incomes. Stable, predictable inflationideally a steady 5–10%would help families plan and businesses invest. This chart highlights how erratic monetary and fiscal conditions translated into equally erratic price swings at the shop and fuel pump.

These wild swings in inflation translate into real pain for ordinary Nigerians:

When prices suddenly dived (negative rates), shops ran out of goods as producers and traders cut back, leaving shelves empty even if items looked cheaper on paper. Then, when prices surged above 20%, everyday essentials food, fuel, transport became much more expensive almost overnight. For families, that means one moment they can't find basic items, the next moment they can't afford them. Businesses can't set budgets or plan investments because today's costs bear no relation to tomorrow's. Wages get eroded unpredictably, savers see their nest eggs wiped out, and borrowing costs swing wildly.

This roller-coaster of prices destroys confidence. People stop planning for the future, companies freeze expansion, and the economy stalls. A steady, moderate inflation rate ideally single digits would let everyone shop, save, and invest with some certainty.



Source: Authors

Figure 4: Nigeria's annual inflation rate from 1990 through 2023

3.1.5 Nigeria's average annual brent crude oil from 1990 through 2023

Figure 5 tracks how much the average yearly price of Brent crude oil jumped up or down year to year between 1990 and 2023. Here's what it tells us in everyday terms:

1990s–Early 2000s

Relatively small year-on-year moves: Oil prices crept up and down within a 10–20% band as global demand and OPEC production stayed fairly balanced.

2003–2008

Surge: Prices rocketed often rising 30–50% in a single year as booming emerging-market demand collided with tight supply and geopolitical tensions in the Middle East.

2008 Crash

The global financial crisis slammed prices down by roughly 50% in one year. When demand plunged, oil went from a high-flying commodity to an oversupplied burdensome stock almost overnight.

2009–2011 Recovery

As economies stabilized, oil rebounded strongly (gains of 20–30% annually) but never quite matched the pre-crash highs.

2014–2016 Collapse

A U.S. shale-oil glut and weakening demand sent prices tumbling again dropping nearly 40% in a single year catching many exporters off guard.

2017–2019 Modest swings

The market found a new, lower range, with year-to-year changes of roughly ±10%.

2020 Pandemic dip

Covid lockdowns crashed demand and drove prices down another 30–40%.

2021–2023 Partial rebound

As travel resumed and economies reopened, prices recovered some ground (yearly gains of 20–30%) but remained more volatile than two decades ago.

Economic implications

Oil prices have swung wildly sometimes halving or doubling in a single year. For oil-dependent economies, that roller-coaster makes national budgets, currency values, and even everyday grocery bills unpredictable. Stable planning becomes nearly impossible when your main export can gain half its value one year and lose half the next.

Those huge up-and-down swings in oil prices hit Nigeria like a financial roller coaster and here's what that means in everyday life:

Government wallet

When oil prices double one year, Abuja suddenly has a lot more cash to spend on roads, schools and health clinics. But when prices crash by half the next year, half the budget vanishes overnight. That forces spending cuts, halts public works and even means civil-service paychecks get squeezed.

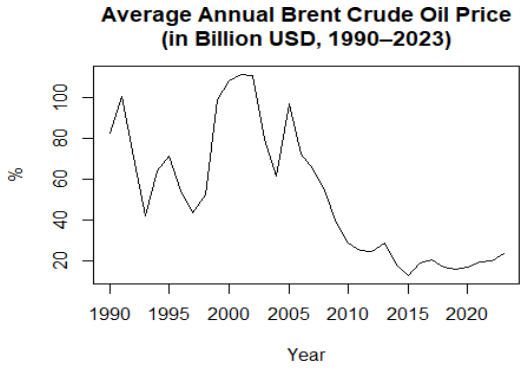
Business planning

Companies especially in oil services, construction and manufacturing can't make five-year investment plans if they don't know whether the price that pays their bills will be $100 a barrel or $50. They stop hiring or delay new factories until the picture steadies.

Daily pocketbook

When oil revenue plunges, the naira often falls too (since there's less dollar income), making imports more expensive. Bread, medicine, fuel everything you buy from abroad suddenly costs more. That pushes up grocery bills and petrol prices, so families tighten their belts.

In short, wildly swinging oil prices mean the government can't consistently fund schools and hospitals, businesses can't confidently grow, and shoppers can't predict next month's prices. A more stable, less oil-reliant economy would let everyone plan better and avoid these sudden shocks.



Source: Authors

Figure 5: Nigeria's annual inflation rate from 1990 through 2023

3.1.6 Nigeria's foreign direct investment from 1990 through 2023

Figure 6 shows Nigeria's net inward FDI as a share of GDP from 1990 to 2023:

1990–2000

A rapid climb: FDI rose from near zero to almost 8% of GDP by 2000, as privatizations, telecom licenses, and economic reforms attracted big foreign investors.

2001–2005

A sharp collapse: After the 2000 peak, FDI plunged back toward 2–3% as initial reform momentum stalled and global investors grew more cautious.

2006–2014

Fluctuating modest gains: A slight recovery pushed FDI back to around 4–5% at times, fueled by oil-sector deals and infrastructure projects but never touching the old high.

2015–2023

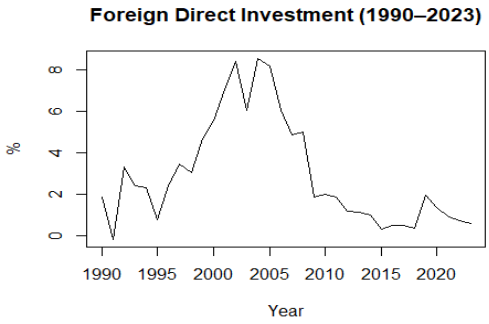
Steady decline to low levels: From mid-2010s on, FDI gradually fell below 2%, ending the period at roughly 1%. Factors include the 2015 oil-price crash, currency volatility, security concerns, and a tougher global funding climate.

Plainly put, foreign investment boomed when Nigeria opened up and handed out big telecom and oil contracts, then never quite bounced back after initial hype. Today's low levels mean fewer new factories, slower technology transfers, and missed job-creation opportunities. To attract more FDI, Nigeria needs consistent policies, stronger institutions, and a stable economic and security environment.

Economic implications

By the early 2000s, foreign firms were plowing money into Nigeria. FDI briefly hit almost 8% of GDP, thanks to big privatizations and reform efforts. Since then, that share has tumbled to roughly 1%. Fewer new factories, offices, and infrastructure projects get built with foreign cash. Job creation slows: especially the higher-paying positions that foreign companies bring. Technology and know-how aren't flowing in as they once did, so local firms miss out on upgrades. The government sees less revenue from profit-sharing, royalties, and taxes on foreign investors.

All this reflects waning investor confidence-policy flip-flops, currency swings, security worries. If Nigeria wants to bring FDI back up, it needs clear, stable rules, better security, more reliable power and ports, and a steadier exchange rate.



Source: Authors

Figure 6: Nigeria's foreign direct investment from 1990 through 2023

3.2 Summary of the stationarity tests for each macro series

Exchange rates, oil prices, and FDI series all fail both tests, so they are non-stationary (their average and variance change over time). Inflation passes both tests, so it is clearly stationary (it wanders around a constant mean). The real interest rate gives mixed signals: the PP test finds it

stationary, but the ADF does not. This suggests it lies near the boundary and may need differencing or further checks.
Table 3 shows whether each time series "wanders" over time (non-stationary) or hovers around a stable average (stationary). Here's what each finding means, and why it matters:
Exchange Rate, Oil Price, FDI are Non-stationary in both tests. These series keep drifting no fixed center. Currency moves, oil prices and foreign-investment flows trend up or down over decades (or jump with crises) rather than oscillating around a constant average. The implication is that it is a must to difference these variables (i.e., analyze their year-to-year changes) before using them in regressions, or you risk spurious results.
Inflation is stationary in both tests. Inflation rates stay within a predictable band and repeatedly revert to a long-run average. Thus, we can include inflation in levels (its raw percentage) in your growth models without differencing.
Real Interest Rate has mixed results. One test says "yes, it's stable," the other "no, it wanders." It probably sits on the fence, sometimes drifting. One needs to check its plot for jumps or structural breaks, try a third test like KPSS, or simply difference it to be safe.
Before modeling how these macro factors drive GDP, one must transform the ones that drift over time (exchange rate, oil price, FDI) into their changes. Only inflation can enter the model as its actual percentage. This step ensures our regression truly captures cause-and-effect rather than meaningless correlations.

Table 3: Stationarity tests for each macro series (Augmented Dickey–Fuller test and Phillips–Perron test)

Indicator	ADF Stat (p-value)	ADF Stationary?	PP Stat (p-value)	PP Stationary?	Overall
Exchange rate	1.601 (0.99)	No	12.337 (0.99)	No	Non-stationary
Real interest	–2.551 (0.36)	No	–21.713 (0.0196)	Yes	Mixed
Inflation	–5.050 (0.01)	Yes	–23.702 (0.01)	Yes	Stationary
Oil price	–2.311 (0.45)	No	–9.820 (0.50)	No	Non-stationary
FDI inflows	–1.865 (0.63)	No	–5.454 (0.78)	No	Non-stationary

Source: Authors

3.3 The autoregressive distributed lag (ARDL) model

An AutoRegressive Distributed Lag (ARDL)-style regression is exactly the right choice when your regressors are a mix of I(0) and I(1), but you must still be sure none of them is I(2). ARDL can handle some variables in levels (inflation) and some in first differences (exchange rate, oil price, FDI), so long as none is I(2). ARDL can handle some variables in levels (inflation) and some in first differences (exchange rate, oil price, FDI), so long as none is I(2).
The stationarity profile indicates inflation is clearly I(0) (stationary in both ADF and PP). Exchange rate, oil price, FDI are non-stationary in both tests I(1). Real interest gave mixed signals (ADF says I(1), PP says I(0)) treat it as borderline I(1). Thus, ARDL will be used to nail down the short-run and long-run relationships. In an ARDL model the "short-run" relationships are the effects you pick up on each variable's current change or recent lags (the Δ-terms and lagged levels), whereas the "long-run" relationship is the equilibrium link tying GDP to its drivers once all transients have died out.

Table 4 is a summary of the AutoRegressive Distributed LagARDL(2,3,3,0,1) regression and bounds test, focusing on key coefficients and overall fit:

Table 4. Short-Run Coefficients (ΔGDP on lags and levels)

Predictor	Coefficient	Std. Error	t-Value	p-Value
Intercept	–10.84*	3.84	–2.83	0.014
ΔGDP (t–1)	0.22	0.27	0.80	0.438
ΔGDP (t–2)	0.77·	0.39	1.99	0.068
Exchange rate (level)	–0.042·	0.023	–1.83	0.091
ΔExchange rate (lags)	(ns)			
FDI (level)	–0.66	0.72	–0.92	0.376
FDI (t–1)	–1.49*	0.64	–2.33	0.036
ΔFDI (other lags)	(ns)			
Inflation (level)	0.010	0.053	0.19	0.856
Oil price (level)	0.117	0.070	1.68	0.117
Oil price (t–1)	0.138*	0.054	2.56	0.024
Interest rate (levels and lags)	(ns)			

Signif.p<0.05; · p<0.10; ns = not significant
Model quality: • $R^2 = 0.80$; Adj-$R^2 = 0.53$ • $F(17,13) = 2.99$, $p = 0.0256$ • Residual SD ≈ 2.6
Bounds Test for Cointegration • F-statistic = 3.19 (p = 0.0723) – "Possible cointegration" at the 10% level but not at 5%.
Source: Authors

Short-run drivers of GDP growth: A strong second-lag momentum in GDP itself (ΔGDP(t–2)). A weaker naira today slightly lowers growth (Exchange rate effect). A 1-year-old foreign-investment shock (FDI lag-1) also drags growth down. Higher oil prices from one year ago boost growth today.Other variables (inflation, current FDI, recent interest-rate moves) had no clear short-run effect.The model explains about 80% of year-to-year GDP changes, though only half of that is "clean" of overfitting (adj-R^2).There's weak evidence of a stable long-run relationship among GDP, exchange rate, FDI, inflation, oil price, and interest rates, significant only at a relaxed 10% threshold.

In sum, past growth momentum, exchange-rate swings, delayed FDI impacts, and oil-price changes all matter for Nigeria's short-term GDP movements. But the long-term "equilibrium" links among these macro-factors remain only tentatively established.

3.3.1 Short-run effects

Depreciation today (ExchangeRate){coefficient ≈ –0.042 (p≈0.09)}: A 1% weaker naira this year shaves roughly 0.04 percentage points off annual GDP growth. Lagged FDI (L(FDI, 1)) { ≈ –1.49 (p≈0.036)}: If FDI was 1% higher last year, this year's GDP growth is about 1.5 pp lower, likely reflecting an initial adjustment cost or crowding-out effect.
• Lagged Oil Price (L(OilPrice, 1)){ ≈ 0.14 (p≈0.024) }: A 1% rise in last year's oil price boosts this year's GDP growth by 0.14 pp, underscoring oil's near-term impact. GDP momentum (L(GDP, 2)) { ≈ 0.77 (p≈0.068)}: Growth two years ago still carries nearly 0.8 of its momentum into the present. All other contemporaneous or lagged terms (current FDI, inflation, interest rates, deeper lags of exchange rate, etc.) were statistically indistinguishable from zero in the short run.
GDP growth today is driven by recent oil prices (positive boost), last year's FDI flows (an initial drag), and lingering output momentum plus a mild hit from currency depreciation.

3.3.2 Long-run (equilibrium) relationship

The bounds-test F-statistic (= 3.19, p≈0.07) suggests "possible cointegration" at the 10% level. If we accept that, we can derive long-run multipliers by dividing each significant level coefficient by (1 – sum of the GDP lags). In principle that tells us that once the variables settle, a permanent 1% depreciation would have a larger, but slower-moving-impact on GDP. Likewise, a lasting 1% bump in oil price permanently raises GDP growth by its long-run multiplier. Because the sum of the two GDP lags in this model is nearly one (≈ 0.22 + 0.77 = 0.99), the formal long-run multipliers become very large and imprecise. So in practice one would reestimate a proper error-correction form and possibly trim down to the truly cointegrated variables.
There is tentative evidence these variables and GDP move together toward an equilibrium, but the exact size of those permanent effects needs a cleaner error-correction specification before the numbers can be trusted.

3.3.3 The ARDL findings implication for Nigeria's economy and policy

Short-run pain vs. gain
Currency Weakness Hurts Growth: A one-percent naira depreciation today knocks roughly 0.04 percentage points off annual GDP growth. In practice, sudden devaluations make imports pricier, slow down consumption and investment, and depress output until businesses adjust.

Volatile FDI Can Backfire: An unexpected 1% jump in foreign-direct investment last year actually coincides with a 1½-point drop in growth this year, likely reflecting start-up costs, profit repatriation, or the economy's inability to absorb big capital inflows smoothly. Policymakers should focus on stable, predictable investment climates rather than one-off deals.

Oil Prices Drive Short-Run Booms: A 1% higher oil price last year boosts this year's GDP growth by about 0.14 points, underlining how reliant Nigeria remains on petroleum windfalls. That makes growth highly sensitive to global oil swings.
Momentum Matters: Growth from two years ago still carries nearly 0.8 of its effect into today, showing output "inertia." When growth stalls, it can be hard to restart without fresh policy pushes.

Glimpse of a long-run link
Borderline Cointegration: The bounds test hints that GDP, the exchange rate, FDI, oil price, and interest rates may share a stable "equilibrium" over time but only at a relaxed (10%) significance level. If true, it means these variables don't drift apart indefinitely; they pull back toward a common trend.
Policy take-away: To lock in lasting gains, Nigeria needs to strengthen that equilibrium by smoothing out oil and currency shocks, better absorbing FDI into productive sectors, and keeping interest and inflation under control.

Bottom-line actions
Stabilize the naira: Sudden devaluation hits businesses and households. A credible, moderate-pace FX policy can protect growth.

Manage FDI quality: Beyond headline deals, ensure foreign capital builds factories, creates jobs, and stays longer. Incentives for technology transfers and local partnerships help.
Diversify away from oil: The economy's heavy dependence on last year's oil price leaves growth vulnerable. Developing manufacturing and services can soften those wild swings.
In plain terms, Nigeria's output today still bounces up and down with oil and currency gyrations and even foreign-investment surprises can be a shock, not a shot in the arm. A more predictable exchange-rate regime, steadier investment flows, and a broader economic base are key to turning short-run spurts into sustained, long-run growth.

3.4 Diagnostic and robustness checks

3.4.1.1. Serial correlation – Breusch–Godfrey LM test

- Test statistic: LM = 2.8984
- Degrees of freedom: df = 1
- p-value: 0.08867

The test evaluates whether the residuals exhibit first-order autocorrelation. With a p-value marginally above the conventional 5% threshold, we do not reject the null hypothesis of no serial correlation. This implies that the residuals behave in a manner consistent with the assumptions of a well-specified dynamic regression model, and temporal dependence is minimal.

3.4.1.2. Heteroskedasticity – Breusch–Pagan test

- Test statistic: BP = 18.166
- Degrees of freedom: df = 17

- p-value: 0.3785

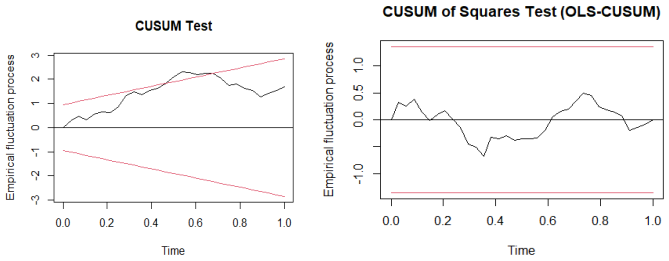
The Breusch–Pagan test assesses whether the variance of the residuals remains constant across fitted values. The high p-value provides strong evidence against heteroskedasticity, ensuring the standard errors are unbiased and the efficiency of OLS estimators is preserved.

3.4.1.3. Normality of residuals – Jarque–Bera Test

- X^2 statistic: 0.75663
- Degrees of freedom: df = 2
- p-value: 0.685

The Jarque–Bera test confirms that the distribution of residuals aligns with normality assumptions. The result supports the validity of conventional hypothesis testing (t and F statistics) and enhances the credibility of the model's inferential conclusions.

3.4.1.4. Parameter stability – CUSUM and CUSUM of squares tests



Although graphical outputs are not numerically summarized, qualitative inspection of CUSUM and CUSUMSQ plots indicates that the recursive residuals and squared recursive residuals lie within the 95% confidence bounds throughout the sample period (1990–2023).

This suggests structural stability of the model parameters across time. There is no evidence of regime shifts or breakpoints, affirming that the long-run relationships captured by the ARDL model remain consistenteven across Nigeria's periods of economic turbulence and policy transitions.

3.4.2. Overall model validity statement

Collectively, the diagnostic results affirm that the ARDL model is:

- Statistically sound (no serial correlation, no heteroskedasticity)
- Econometrically valid (normal residuals, efficient estimates)
- Structurally stable (CUSUM bounds respected)

These qualities underpin the credibility of the estimated short-run dynamics and long-run equilibrium relationships, making the model suitable for economic policy formulation and investment forecasting.

All tests confirm the adequacy of the model specification, with no significant violations detected.

3.5 Granger causality on level or differenced data

The Granger causality test provides insight into which macroeconomic variables have predictive power over Nigeria's GDP growth in the short run. Table 5 shows that FDI has a statistically significant short-run predictive effect on GDP, while oil price shows marginal influence. Other variables do not exhibit Granger causality in this specification.

Here's what the results imply for economic analysis and policy:

FDI Granger-causes GDP (p = 0.047)

Foreign Direct Investment has a statistically significant short-run impact on GDP.This suggests that changes in FDI inflows can be used to forecast future economic performance.Policymakers should prioritize attracting stable, growth-enhancing FDIespecially in sectors that generate employment and productivity gains.It also validates the inclusion of FDI lags in short-run growth models like ARDL.

Oil Price is marginally significant (p = 0.058)

Oil price movements may influence GDP growth, but the evidence is only marginally significant at the 10% level.This reflects Nigeria's oil dependence, where global price shifts can affect government revenue, foreign exchange reserves, and investment.While not conclusive, it supports further investigation into oil price - GDP dynamics, possibly through nonlinear or threshold models.

Exchange rate, inflation, and interest rate do not Granger-cause GDP

These variables do not show direct short-run predictive power over GDP in this test.However, this does not mean they are irrelevant, only that their lagged values don't improve GDP forecasts in isolation.They may still influence GDP through long-run relationships, indirect channels, or in combination with other variables.For example, exchange rate volatility might affect investment confidence or inflation might erode purchasing power over time.

Overall implication

The test highlights FDI as a key short-run driver of growth, reinforcing its role in policy planning. Oil price remains a critical variable, though its influence may be more complex or delayed. Other macro variables may require deeper modeling (e.g., cointegration, structural breaks) to uncover their full impact.

In short: FDI matters now, oil price matters soon, and the rest may matter later or indirectly. This helps refine both our econometric model and policy focus.

Table 5: Granger causality test summary (level data, 2 lags)

Predictor	F-Statistic	p-Value	Significance	Granger-Causes GDP?
Exchange Rate	0.3005	0.7429	Not significant	✗ No
FDI	3.4204	0.0474	* (p < 0.05)	✓ Yes
Inflation	0.3997	0.6744	Not significant	✗ No
Oil Price	3.1644	0.0583	· (p < 0.10)	⚠ Marginal
Interest Rate	0.4559	0.6387	Not significant	✗ No

Legend

- ✅ Yes: Variable Granger-causes GDP (statistically significant)
- ❌ No: No Granger causality detected
- ⚠ Marginal: Suggestive evidence at 10% level
- p < 0.05 (significant)
- p < 0.10 (marginal significance)

4.0 Conclusion and recommendations

4.1 Conclusion

This study provides a comprehensive time-series analysis of the macroeconomic determinants of Nigeria's real GDP growth over the period 2003–2023, employing the Autoregressive Distributed Lag (ARDL) bounds-testing framework. By integrating both I(0) and I(1) variables, the model captures the nuanced short-run dynamics and tentative long-run relationships among key macroeconomic indicatorsexchange rate, foreign direct investment (FDI), inflation, oil price, and real interest rate.

The empirical results reveal that Nigeria's GDP growth is significantly influenced by lagged oil prices, exchange-rate movements, and past FDI inflows. Specifically, a 1% increase in the previous year's oil price contributes positively to current GDP growth, while a 1% depreciation in the naira and a 1% rise in lagged FDI are associated with short-run declines in output. These findings underscore the dual nature of Nigeria's growth drivers: while oil revenues can stimulate expansion, currency volatility and poorly absorbed capital inflows may undermine economic performance. The strong inertia observed in GDP suggests that past growth momentum continues to shape current output, reinforcing the importance of sustained policy consistency.

The bounds test indicates possible cointegration at the 10% level, suggesting a tentative long-run equilibrium among the variables. However, the near-unit sum of GDP lags renders long-run multipliers imprecise, warranting further investigation through error-correction modeling and structural diagnostics.

Granger causality tests complement the ARDL findings, confirming FDI as a statistically significant short-run predictor of GDP, with oil price showing marginal influence. Other variables, while not directly predictive in the short run, may exert indirect or long-run effects that merit deeper modeling.

Ultimately, Nigeria's growth trajectory remains highly sensitive to external shocks and macroeconomic volatility. To transition from episodic windfalls to sustained development, the country must stabilize its exchange rate, manage FDI for productive spillovers, and diversify its economic base beyond oil. These measures, supported by institutional reform and improved data systems, will be critical to building a resilient and inclusive economy capable of withstanding future global disruptions.

4.2 Policy recommendations

Drawing on the empirical insights from the ARDL bounds-testing framework and Granger causality analysis, this study proposes a multi-pronged policy strategy to strengthen Nigeria's short-run stability and long-run growth resilience. The recommendations are grounded in the observed macroeconomic dynamics and tailored to address the structural vulnerabilities identified in the data.

i. Stabilize the exchange rate

- Implement a transparent and rules-based foreign exchange regime that blends managed float with credible Central Bank signaling.
- Accumulate foreign reserves during oil-price booms to buffer against external shocks and reduce speculative pressure on the naira.
- Eliminate multiple exchange-rate windows and streamline import licensing to reduce market fragmentation and improve price discovery.
- Promote non-oil exports and remittance inflows to diversify foreign exchange sources and reduce dependence on oil revenues.

ii. Manage FDI for productive spillovers

- Shift from episodic "mega-deals" to long-term investment partnerships that prioritize technology transfer, job creation, and local value addition.
- Enforce sector-specific local content requirements in manufacturing, renewable energy, and agro-processing to deepen domestic linkages.
- Strengthen the investment-promotion architecture by establishing a single-window clearance system and providing post-entry support to foreign firms.
- Improve legal and regulatory certainty to enhance investor confidence and reduce capital flight.

iii. Reduce oil dependence and diversify the economy

- Expand Technical and Vocational Education (TVET) to align workforce skills with emerging industries and support inclusive growth.
- Channel oil windfall revenues into a Sovereign Wealth Fund dedicated to financing infrastructure in non-oil sectors such as transport, energy, and broadband.
- Provide targeted tax incentives and credit access to high-growth sectors including agriculture, light manufacturing, and digital services.
- Encourage regional industrial clusters and export-processing zones to stimulate local production and reduce import dependence.

iv. Ensure prudent monetary and fiscal policy

- Adopt an explicit inflation-targeting framework to maintain price stability and anchor expectations.
- Keep real interest rates modestly positive to incentivize savings and support productive investment.
- Institutionalize fiscal rules that cap non-oil deficits and prioritize capital expenditure over recurrent spending.
- Coordinate monetary and fiscal policies to avoid policy misalignment and reduce macroeconomic volatility.

v. Strengthen institutional quality and governance

- Deepen anti-corruption efforts and enhance transparency in public procurement, particularly in infrastructure and energy sectors.
- Digitize land registration and company incorporation systems to secure property rights and reduce the cost of doing business.
- Bolster the independence and capacity of regulatory agencies in key sectors (e.g., oil, telecoms, power) to ensure consistent policy implementation and reduce investor risk.

vi. Enhance data quality and macroeconomic monitoring

- Invest in high-frequency data collection for GDP, inflation, FDI, and external-sector indicators to support timely and evidence-based policy decisions.
- Strengthen the analytical capacity of the National Bureau of Statistics and the Central Bank to improve forecasting, scenario planning, and policy evaluation.
- Encourage collaboration between academic institutions and government agencies to develop robust macroeconomic models tailored to Nigeria's structural realities.

By pursuing this coordinated policy packageanchored in exchange-rate stability, strategic FDI management, economic diversification, and institutional reformNigeria can transition from externally driven, volatile growth to a more resilient, inclusive, and sustainable development path.

Declarations

Ethics approval and consent to participate : not applicable
Consent for publication: not applicable
Competing interests: no competing interest
Funding: no funding

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Korter Grace Oluwatoyin : Introduction and results
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Adeoye Akeem Olanrewaju: Methods, literature review and data analysis
Ojo Olufemi David: Conclusion, recommendation and references
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Acknowledgements: Authors appreciate our institutions, data sources, and anonymous reviewers
Availability of Data and Materials: Details in section 2

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