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Article

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Trade openness, hydroelectric power production, foreign direct investment and economic growth nexus in Nigeria

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ABSTRACT

This study examines trade openness, hydroelectric power production, and foreign direct investment (FDI) nexus on economic growth in Nigeria. Despite efforts toward trade liberalisation, Nigeria's growth remains constrained due to heavy reliance on oil and minerals exports. Furthermore, electricity production challenges exacerbate these issues, hindering intra-African trade, FDI inflows, and overall economic growth. The study explores how trade openness and insufficient electricity production affects economic growth in the long run. The annual data from 1988 to 2022, sourced from the National Bureau of Statistics, Nigeria, Our World in Data, and the World Bank Development Indicator (WDI) database was used. The econometric techniques employed are the autoregressive distributed lag (ARDL) to examine long-run and short-run dynamics, while the dynamic ordinary least squares (DOLS) is used as a robustness to address potential endogeneity and serial correlation concerns. The findings indicate that trade openness positively affects long run economic growth, as supported by DOLS estimates. However, hydroelectric power production and FDI had mixed effects on Nigeria's economic performance. The study recommends prioritising investments in electricity infrastructure to enhance trade competitiveness and attract FDI. Moreover, diversifying exports beyond oil and minerals is crucial for strengthen economic resilience and drive sustainable development in Nigeria.

IMPACT STATEMENT

This study provides critical insights into sustainable economic development in Nigeria by examining key factors affecting its growth. Through an in-depth analysis of trade openness, hydroelectric power production, and foreign direct investment (FDI), the research highlights both the drivers and barriers within Nigeria's economic trajectory. Findings show that trade liberalisation, enhanced electricity infrastructure, and targeted FDI are essential for supporting long-term economic expansion. These insights align with Nigeria's goals of economic diversification and energy security. The implications of this study are substantial, offering policymakers guidance for strategies that promote both growth and inclusive development. By uncovering the interconnected effects of trade, energy, and investment policies, this work provides a framework for informed national and regional economic planning. The research has the potential to shape decisions on resource allocation, regulatory reforms, and investment priorities, positioning Nigeria towards sustainable industrialisation and resilient economic transformation.

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Economics; Economics and Development; Development Policy

Introduction

Nigeria, one of Africa's largest economies, substantially impacts the region's economic performance. Despite being richly endowed with abundant oil, minerals, and other natural resources, Nigeria paradoxically experiences low economic growth. This stagnation is largely attributed to a lack of robust manufacturing and agricultural industries that drive broader economic expansion. While exchanging goods and services offers significant potential benefits, Nigeria's non-oil export performance falls short

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compared to oil-producing countries such as the UAE, Russia, and Saudi Arabia, where manufacturing and agriculture thrive alongside oil production. Previous research has attributed this underperformance to several factors, including overreliance on oil exports, insufficient trade openness, recent border closures and lack of political will to pursue aggressive diversification of non-oil exports. This study, however, posits that effective trade openness is contingent upon substantial improvements in infrastructure, particularly electricity supply and distribution, that will enhance manufacturing. The World Bank (1994) identifies infrastructure as a key determinant of manufacturing and agricultural success.

Consequently, this research concentrates on the pivotal role of trade openness in enhancing a country's growth potential, a notion widely discussed in theoretical literature on growth and trade (Fetahi-Vehapi et al., 2015; Islam, 2024). Based on this notion, developing nations, including Nigeria, have pursued export promotion and openness, particularly during the trade liberalisation era, aiming to foster trade, knowledge exchange, technology transfer, labour specialisation, investment, improved welfare, efficient resources allocation, and overall development (Gold & Rasiah, 2022). However, the trade openness, economic growth impact is subject to debate and lacks conclusive evidence. Some studies, like those by Samimi et al. (2012) and Cooke (2010), reason that trade openness will hinder economic growth, potentially leading to persistently higher commodity prices and lower exchange rates. Similarly, Malefane and Odhiambo (2021) and Musila and Yiheyis (2015) suggest an insignificant trade openness and economic growth nexus. In addition, Ogudu et al. (2023), Rakshit (2022), and Khobai et al. (2018) find a significantly negative impact of trade openness on economic growth. Contrarily, Sunde (2023), Malefane (2020), Ma et al. (2019), and Khobai et al. (2018) findings indicate a significant and positive relationship between trade openness and economic growth. Moreover, Esaku (2021), Islam (2021), Sriyana and Afandi (2020), Islam et al. (2022) and Kong et al. (2021) identify a positive correlation between trade openness and economic growth in various countries.

These studies suggest that increased international competitiveness, productivity and export revenue are integral to economic growth and directly and significantly affect trade openness. Likewise, Keho (2017)and Brueckner and Lederman (2015) argue that trade openness encourages domestic firms to invest and transfer technology, thereby increasing GDP. However, owing to the increasing realisation of the fact that Nigeria – '*the giant of Africa*' (Ozughalu & Ogbuefi, 2022, p. 37181) contribution to global markets in terms of manufacturing is low despite its trade liberalisation reforms, except for its dominance in oil and minerals export, which account for over 70% of its total foreign earnings (Khobai et al., 2018). This overreliance on oil and minerals underscores Nigeria's struggle with challenges and shortages in electricity[1] production. These limitations hinder intra-African trade, foreign investment and impede growth, as illustrated in Figure 1.

This electricity infrastructure is crucial to socio-economic activities across industrial, manufacturing, agricultural, commercial, residential and transportation sectors (Yakubu et al., 2015). It is considered a cornerstone of energy banks in both developing and developed nations. However, Nigeria's unreliable power generation and epileptic power supply have led to numerous business closures, prompting some companies to relocate to countries with more accessible and reliable electricity supply (Adenikinju, 2005;

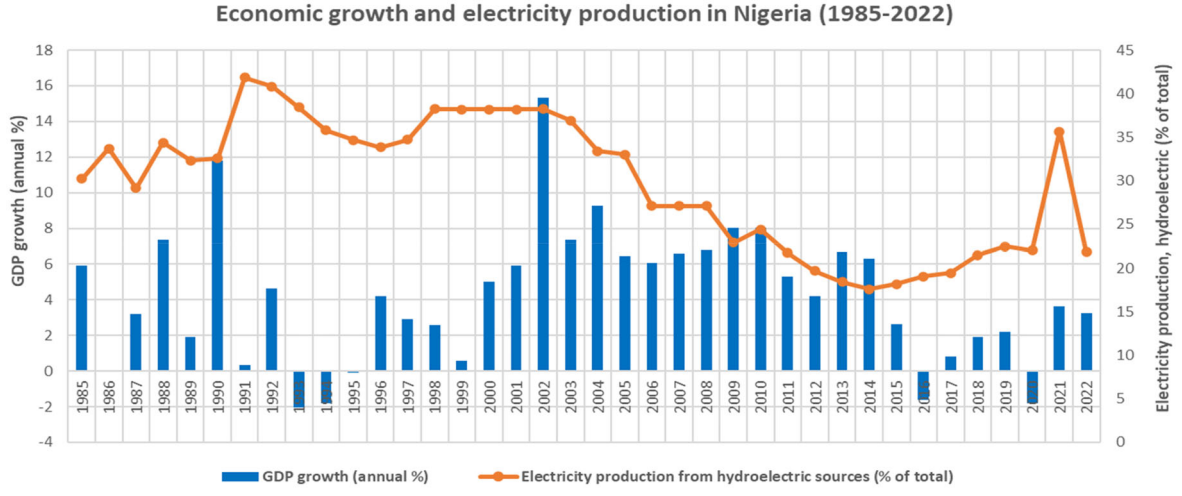

Figure 1. Nigeria's GDP and electricity production computation from World Bank (2024); Statistics (2022).

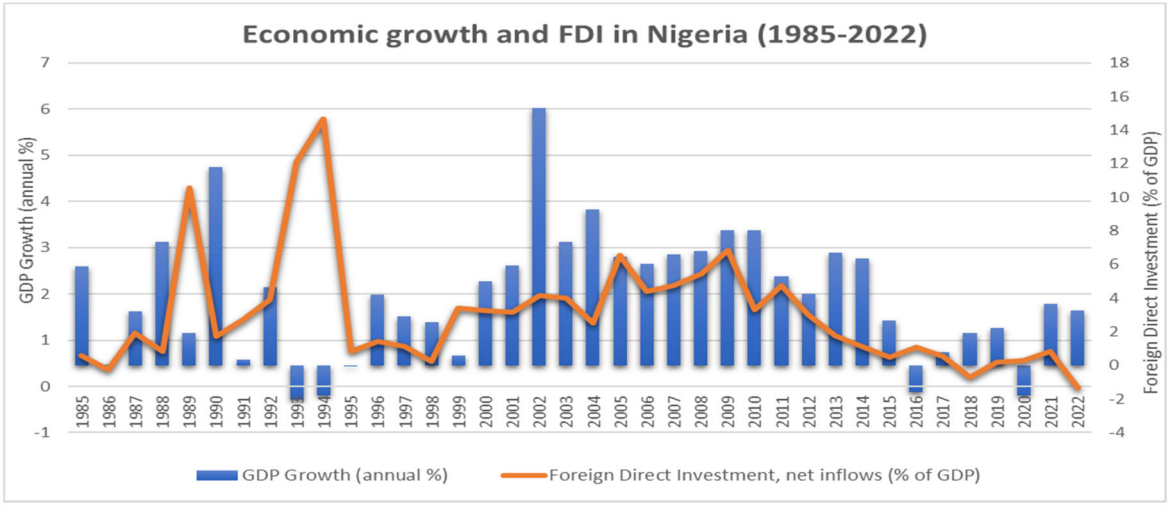

Figure 2. Nigeria's GDP and FDI computation from World Bank (2024).

Egbichi et al., 2018; Ozughalu & Ogbuefi, 2022). Many individuals and firms in Nigeria also use generators for electricity, which is costlier than the national power supply (Kennedy-Darling et al., 2008; Musibau et al., 2024). Invariably, the inadequate electricity supply imposes additional costs on production, leading to inflation in the prices of goods and services (Adenikinju, 2005; Musibau et al., 2024). More so, infrastructure, including electricity, constitutes a significant portion of the total capital stock (Carlsson et al., 2013), and foreign investors prefer to invest in countries with constant, reliable, and sufficient electricity supply to increase productivity and maximise profits. As shown in Figure 2, Nigeria's GDP growth tallies with a dwindling trend in FDI. Additionally, FDI is crucial for enhancing the manufacturing sector's functionality, which impacts export volume and resource refinement, fostering growth through technology and knowledge transfer. Undoubtedly, it is evident that Nigeria requires foreign capital inflow, particularly in the form of FDI, partly to finance its electricity infrastructure, which is grossly deficient and to enhance trade competitiveness (Musibau et al., 2024).

Akin to the studies on openness-economic growth, previous research on electricity-economic growth and FDI-economic growth yields mixed results. Aydin and Bozdağ (2018), Qazi et al. (2021), Apinran et al. (2022), Nasreen and Anwar (2014), Nchege and Okpalaoka (2023) and Lawal et al. (2020) find a direct relationship between electricity and economic growth, indicating that electricity is vital for sustainable growth and leads to increased economic output. However, Egbichi et al. (2018) and Rahman and Mamun (2016) argue that no causal relationship exists between energy consumption and growth. Likewise, Ogudu et al. (2023), Qabrati (2021), Al-Harbi and Shaheen (2021), Musibau et al. (2019); Qazi et al. (2021), Kumari et al. (2023) suggest a positive impact of FDI on growth, whereas, Musibau et al. (2024) and Tran et al. (2023) find a negative relationship. Moreover, these studies focus on openness-electricity-growth, energy (electricity)-FDI-growth, or FDI-openness-growth nexus.

Given the above, the lacuna studied here specifically is to determine the link between trade openness, electricity production, and FDI and economic growth in Nigeria, as no existing literature arguably investigates all four linkages simultaneously. By doing so, we aim to provide policymakers with insights for creating an environment conducive for industrial development. The findings are expected to inform policies that enhance manufacturing sector efficiency and competitiveness, ultimately contributing to a more diversified and resilient Nigerian economy. Secondly, this study deviates from the previous studies and uses data on electricity production instead of electricity consumption. The notion is that the power supply from the national grid generated by the government, which is not supplemented by alternatives from firms and individuals, is best captured and better measured with electricity production data than consumption. This approach provides a unique perspective on the country's energy challenges. Furthermore, Nigeria's primary energy source, hydroelectric power, adds significance to this choice. Thirdly, utilising robust econometric techniques such as ARDL and DOLS over an extensive secondary data spanning from 1988 to 2022, the study offers comprehensive insights into long-run and short-run effects, which contribute to a deeper understanding of Nigeria's economic growth dynamics,

while highlighting important policy implications. The structure of the paper is as follows: the literature, the methodology, the results and discussion, and the last section contains the conclusions.

The review of related literature

Theoretical review on trade openness, electricity, FDI and economic growth nexus

Neo-classical economists argue that no nation is self-sufficient to cater for all the required resources needed for economic development. Instead, nations should specialise and concentrate on areas with greater factor endowment, strong technical capacity to produce exports at a lower cost advantage, benefit from economies of scale to expand the industrial base and import resources that are either scarce, unavailable or have high-cost disadvantage to accelerate economic growth. For this reason, achieving a favourable trade balance and a positive trade is a mirage for many developing nations lacking abundant resources, technology that includes labour and capital and a low degree of openness (Keho, 2017; Khobai et al., 2018; Omoke & Opuala–Charles, 2021; Sriyana & Afandi, 2020). The export-led growth hypothesis states that increasing exports boosts productivity and market access, leading to economic growth (Gold & Rasiah, 2022; Islam, 2021). The hypothesis found a significant correlation between export level and economic performance (Dreger & Herzer, 2013). A critical component of this process is electricity infrastructure, which is vital for global economic activities, as it underpins the functioning of industries and services worldwide. According to Nurkse (1953) theory, inadequate electricity infrastructure poses a major obstacle to economic progress, particularly in less developed nations. Thus, ensuring a reliable and high-quality electricity supply is pivotal for determining a country's success in trade, poverty alleviation, and environmental improvement (Estache, 1994). Furthermore, the Grossman and Helpman (1991) and Romer (1990) endogenous growth models, emphasise technological advancement, innovation, and knowledge transfer as primary catalysts for economic growth. In which FDI acts as a conduit for knowledge dissemination, stimulating employment, heightening growth rates, expanding market access, improving trade quality, and facilitating economic integration and globalisation in developing nations (Gold, 2022; Tran et al., 2023). In addition, the Solow-type neoclassical growth models indicate that FDI enhances capital stock and fuels economic growth through capital formation (Brems, 1970; Gold, 2019). Combined with the empirical findings, these theories are the basis for model specification.

Empirical review

Trade openness - economic growth

In countries that open up to trade and export to other countries, their domestic industries will produce more, which will drive growth (Krueger, 1998). According to Alwafi (2017), low-income nations with higher trade openness leverage the abundant technological advancements from developed nations to develop local industries and promote growth. The former will grow quicker than the latter. Other explanations suggest that trade openness might negatively affect growth in emerging and low-income economies (Gonçalves et al., 2021). This alternative view is based on the notion that their structural attributes and trade policies incline to change the terms of trade at their disadvantages, particularly for countries specialising in low-quality products (Alwafi, 2017). Despite these differing views, this study maintains that trade openness and economic growth positively affects each other in developing countries, including Nigeria, as summarised in Table 1.

Electricity Production - Economic growth

Samli (2010) and Musibau et al. (2024) stress the critical role of electricity in national growth and development. The development of electricity infrastructure yields several benefits, including increased manufacturing output, expanded trade opportunities, job creation, and improved living standards. However, Nigeria's situation presents a stark contrast. Despite substantial government investments and incentives in the electricity sector, adequate electricity supply remains challenging. The production-consumption gap is significant, exemplified by Nigeria's need for 40,000MW of electricity in 2020, while only 7,500MW was supplied. Moreover, access to electricity is unevenly distributed, with only 55% of urban dwellers having access, while rural areas face greater challenges, with just 36% having access. Approximately 40% of Nigeria's over 210 million population lack electricity access (Apinran et al., 2022; Egbichi et al., 2018). Certainly, Table 2 presents additional studies examining

Table 1. Empirical review summary of trade openness - economic growth.

Source	Sample / Duration	Variables	Estimation Technique/ Model	Main findings
Tripathi (2023)	G20 developed countries (2004-2019)	Trade openness (trade share of GDP)	Simultaneous equations and dynamic policy simulation models	Trade openness-GDP (correlate positively). Dynamic policy simulations: Policies to increase exports, reduce inflation, and FDI need to be stronger and more practical to enhance per capita growth.
Sunde et al. (2023)	Namibia (1990-2020)	Trade openness (trade % GDP)	Autoregressive distributed lag (ARDL)	Trade openness-exports-GDP (positive); Imports-GDP (negative); Openness-exports-imports = growth in shortrun.
Esaku (2021)	Uganda (1983-2019)	Trade openness	ARDL	Export indices proxy = insignificant. Openness and imports indexes = significantly positive in longrun.
Omoke and Opuala–Charles (2021)	Nigeria (1984-2017)	Total trade, import trade, and export trade (trade openness)	ARDL	Trade openness-economic growth (export trade = significantly positive in the long run; import trade = significantly negative in the long run. Good governance increases economic growth.
Nwadike et al. (2020)	Nigeria (1970-2011)	Trade openness (trade divided by GDP)	ADF and ordinary least squared (OLS)	Trade openness-GDP (significantly positive impact); GDP and exchange rate respond to the shock of trade openness.
Udeagha and Ngepah (2021)	South Africa (1960-2016)	Trade openness (trade % GDP; (trade size % global trade)	Nonlinear ARDL	Trade openness-economic growth (long and short-run asymmetric effects).
Islam (2021)	Saudi Arabia (1985-2019	Trade, Gross fixed capital formation (GFCF) and labour	ARDL; Toda-Yamamoto Granger causality test	Trade openness and labour have positively significant on GDP in the short and long run; GFCF has no significance impact on GDP in all estimates.
Malefane and Odhiambo (2021)	Lesotho (1979-2013)	Trade openness index; 3 trade-based proxies	ARDL	Trade openness-economic growth (no significant impact in the long run and short run).
Malefane (2020)	Botswana (1975-2014)	Trade openness	ARDL	Imports/GDP ratio proxy (not significant). Trade/GDP ratio, exports/GDP ratio, and trade openness index proxies (significantly positive).
Ijirshar (2019)	ECOWAS (1975-2017)	Trade openness (trade % GDP)	Pooled mean group (PMG)	Trade openness-economic growth (long-run = positive impact; short-run = mixed effect).
Khobai et al. (2018)	Ghana and Nigeria (1980-2016)	Trade (imports + exports)	ARDL; Augments Dickey-Fuller; DF-GLS	Trade openness-GDP in Ghana (positive longrun/shortrun). Trade openness-GDP in Nigeria (negative-longrun; positive-shortrun).
Keho (2017)	Cote d'Ivoire (1965-2014)	Trade openness (real trade per capita)	ARDL; Granger causality approaches	Openness-growth (positive). Openness-capital formation-growth (positive/complementary).

Table 2. Empirical review summary of electricity production - economic growth.

Source	Sample / Duration	Variables	Estimation Technique/ Model	Main findings
Nchege and Okpalaoka (2023)	Nigeria (1981-2018)	Electricity Production; electric power consumption	ARDL	Hydroelectric power production and GDP = negative long-term effect; Electric power consumption and GDP = positive. GDP rises (1.3%) as hydroelectric power is used for electricity production.
Apinran et al. (2022)	Nigeria (1981-2019)	Electricity consumption (kwH)	ARDL and novel dynamic ARDL	Electricity consumption, labour, and capital = positive impacts on growth; Carbon emissions = significantly negative impact on growth.
Ozughalu and Ogbuefi (2022)	Nigeria (1970-2018)	Electricity consumption; FDI	ARDL, Granger causality and vector error model	Electricity to GDP per capita = neutral causality/short run; unidirectional causality/long run. FDI to electricity = unidirectional causality both; FDI to GDP per capita = neutral causality in both.
Qazi et al. (2021)	Pakistan (1971-2017)	Electricity consumption	ARDL	Electricity consumption and GDP = a significantly positive long-run relationship.
Lawal et al. (2020)	SSA (1971-2017)	Electric power consumption	GMM estimation techniques	A positive and significant relationship between electricity consumption and economic growth.
Egbichi et al. (2018)	Nigeria (1986-2016)	Electric power consumption	Symmetrical ARDL approach	Electricity consumption-growth = No significant impact
Wada (2017)	Nigeria (1971-2013)	Energy production	ARDL and Granger causality	There is no significant long-run integration between the variables examined in the model.

electricity's impact on economic growth and other economic variables. These studies contribute to understanding how electricity infrastructure influences economic development and trade dynamics.

Foreign direct investment - economic growth

According to Kumari et al. (2023), Alwafi (2017) and Ogudu et al. (2023), factors influencing the inflows of FDI include the host country's economic and political environment, innovation, technological development, exchange rates, infrastructure, and trade openness. Krugman and Obstfeld (2000) and Alwafi (2017) stated that with FDI, capital flows from multinationals in developed countries to establish subsidiaries or acquire controlling interests in host markets, catalysing economic development through capital accumulation and project financing in the host and home countries. However, with its enormous natural and human resources, Nigeria lacks capital accumulation primarily due to insufficient domestic savings, exchange rate volatility and infrastructural deficits (electricity, road, etc). This shortage in electricity supply particularly restricts businesses and discourages the inflow of FDI in critical sectors where reliable electricity infrastructure is required (Musibau et al., 2024; Musibau et al., 2019; Ogudu et al., 2023). Hence, FDI is pivotal in driving economic growth, especially in developing countries, Nigeria inclusive, as shown in the summary of the review in Table 3.

The study addresses a critical gap in the existing literature by analysing the intricate relationships between trade openness, hydroelectric power production, FDI, and economic growth in Nigeria. Unlike previous research, which often focused on individual factors or broader economic trends, this study examines how these elements shape Nigeria's economic landscape. The research also highlights the importance of infrastructure, particularly electricity supply, in facilitating trade and industrial activities, thereby contributing to a more comprehensive understanding of the country's economic challenges and opportunities.

Research methodology

Data source and variables descriptions

The study uses data with yearly observations at the country level, obtained from the WDI database, supplemented by electricity generation data from the National Bureau of Statistics, Nigeria, and Our World in Data. The available datasets cover from 1988 to 2022. It measures trade openness, electricity production, and FDI's impact on economic growth in Nigeria. The key variables for the study are grouped into dependent, independent, and controlled variables. Economic growth is the dependent variable; it measures the GDP growth of a country (annual %). GDP growth effectively captures dynamic economic relationships, offers better statistical properties (such as improved stationarity and reduced heteroscedasticity), and aligns more closely with growth theories (Duramany-Lakkoh et al., 2022; Julius, 2018). Trade openness measures the sum of imports and exports as a % share of a country's GDP (Tripathi, 2023); Electricity production measured in megawatts (MW), is the energy derived from hydroelectric power (Nchege & Okpalaoka, 2023); and FDI is the net inflow from foreign investors' economy to the host economy in the percentage of GDP (Gold, 2022) are independent variables. The controlled variables are fixed capital formation, measured as the net change in a nation's physical capital stock, calculated as investment minus disposals of assets over a defined period (Al-Harbi & Shaheen, 2021; Islam & Alhamad, 2023), total labour force, and bank credit to private investors, measured in US$ (Adeusi & Oke, 2013).

Model specification and estimation techniques

In line with the theoretical and empirical reviews which justify the relationships and the *aprior* expectations between gross domestic product growth (GDPG), trade openness (TOP), electricity production (EPP), foreign direct investment (FDI), fixed capital formation (FCF), total labour force (LBR) and bank credit to private investors (DCPSBB) in Nigeria, the study modified the models of Malefane and Odhiambo (2021), Egbichi et al. (2018) and Sunde (2023); and employ autoregressive distributed lag (ARDL) bounds model by Pesaran and Shin (1995) and Pesaran et al. (2001) and dynamic ordinary least squares (DOLS) by Engle and Yoo (1989) to analyse the specified Eqs. (3) and (4). The benefit of the

Table 3. Empirical review summary of FDI - economic growth.

Source	Sample /Duration	Variables	Estimation Technique/Model	Main findings
Ogudu et al. (2023)	Nigeria (1980-2017)	FDI; trade openness	Vector error correction (VAR)	Trade openness and GDP = negative long-run link. FDI and GDP = positive long-run link.
Tran et al. (2023)	Vietnam, 63 provinces (2005-2020)	FDI flows	Bayesian Modelling	FDI/provinces - GDP = negative effect. The interaction between FDI - and institutional quality = positive impacts on GDP.
Kumari et al. (2023)	India (1985-2018)	FDI inflows; trade openness	Johansen cointegration; VAR	GDP causes FDI; FDI causes GDP (bi-directional causality). Trade openness and GDP (no bi-directional causality).
Onwioduokit and O'Neill (2023)	Nigeria (1980-2022)	Bank credit to private sector (CPS), inflation	ARDL; Granger causality test	GDP and CPS is positively significant in long-run, but negative in the short-run. CPS does not Granger Cause RGDP and vice-versa.
Ayenew (2022)	SSA (1988-2019)	FDI	PMG/ARDL	FDI and GDP (significantly positive in the longrun; insignificant in the shortrun).
Qabrati (2021)	Kosovo (2007-2017)	FDI, net capital inflows	Multiple linear regression model	FDI's effect on GDP is positive and significant.
Al-Harbi and Shaheen (2021)	Saudi Arabia (1992-2017)	FDI	ARD	FDI and fixed capital formation have a significantly positive impact on economic growth.
Musibau et al. (2024)	Nigeria (1980–2017)	FDI, energy security	Quantile-on-quantile technique	FDI-GDP is insignificant/negative. Energy security- GDP is negative. Globalisation-GDP is positive.
Musibau et al. (2019)	ECOWAS (1980-2017)	FDI	ARDL	FDI has a significant impact on the economic growth of ECOWAS member countries.

ARDL estimator is that the lag lengths of the co-integration symmetry are not required. Also, ARDL tests the co-integration and analyses dynamic long and short-run relationships in the models without altering the equilibrium of the time series. The DOLS serves as a robustness check to assess the long-term impact of the variables. In addition to this, it addresses potential endogeneity and serial correlation issues in the time series data, providing more accurate and reliable estimates.

Hence, the adapted aggregate production function model is as follows:

$$Y_t = KL_t \tag{1}$$

where Y_t is the output of an economy at time t. K_t denotes the stock of capital and L_t is the stock of labour. Thus, Eq. (1) is expanded as follows:

$$Economic\ \ growth_t = f(K_t, L_t, A_t) \tag{2}$$

Where the dependent variable is Nigeria's GDP growth in time t, K_t and L_t are capital and labour, respectively, and A_t represents other variables like trade openness, electricity production, FDI, and explanatory variables related to economic growth.

$$GDPG_t = f(TOP_t, EPP_t, FDI_t, GFCF_t, LBR_t DCPSBB_t) \tag{3}$$

Equation (3) is transformed into a stochastic form as follows:

$$GDPG_t = A_0 + A_1 TOP_t + A_2 EPP_t + A_3 FDI_t + A_4 GFCF_t + A_5 LNLBR_t + A_6 DCPSBB_t + \varepsilon_t \tag{4}$$

In the specified models, the dependent variable is measured as $GDPG_t$ (economic growth). The independent variables are *TOP* (trade openness), *EPP* (electricity production), *FDI* (foreign direct investment), while the three control variables are *GFCF*, *LNLBR* and *DCPSBB* which measures gross fixed capital formation, log of total labour force and bank credit to private investors, respectively. Here, $A_i\ \ (i = 0, 1, 2, 3, 4, 5, 6)$ represents the parameters of the coefficients of the explanatory variables; t is time; ε is the error term that accounts for influences of other variables that are not included in the model. Thus, to test whether there is, or not a long-run relationship among the variables specified in model 4, the ARDL model bounds test procedure is represented as follows:

$$\begin{aligned}\Delta GDPG_t = {} & A_0 + \sum_{j=1}^{b} A_{1i}\Delta GDPG_{t-j} + \sum_{j=0}^{c} A_{2i}\Delta TOP_{t-j} + \sum_{j=0}^{d} A_{3i}\Delta EPP_{t-j} + \sum_{j=0}^{e} A_{4i}\Delta FDI_{t-j} + \sum_{j=0}^{f} A_{5i}\Delta GFCF_{t-j} \\ & + \sum_{j=0}^{g} A_{6i}\Delta LNLBR_{t-j} + \sum_{j=0}^{h} A_{7i}\Delta DCPSBB_{t-j} + \ A_{1i}TOP_{t-1} + A_{2i}EPP_{t-1} + A_{3i}FDI_{t-1} + A_{4i}GFCF_{t-1} \\ & + A_{5i}LBR_{t-1} + A_{6i}DCPSBB_{t-1}\ + \varepsilon_t \end{aligned} \tag{5}$$

Furthermore, the F statistic tests the null hypothesis (Ho) against the alternative hypothesis (H_1) of whether no co-integration exists among the variables. It is expressed as $H_0: A_1 = A_2 = A_3 = A_4 = A_5 = A_6 = A_7 = 0$; $H_1 : A_1 \neq A_2 \neq A_3 \neq A_4 \neq A_5 \neq A_6\ \ \neq A_7 \neq 0$. Then, the ARDL unrestricted error correlation model (ECM) specified in Eq. (6) examines the variables' causal factors and forms long-run equilibrium. Including ECM in the model aims to determine the rate at which the variables adjust back to their long-term equilibrium path following any short-term disequilibrium.

$$\begin{aligned}\Delta GDPG_t = {} & A_0 + \sum_{j=1}^{b} A_{1i}\Delta GDPG_{t-j} + \sum_{j=0}^{c} A_{2i}\Delta TOP_{t-j} + \sum_{j=0}^{d} A_{3i}\Delta EPP_{t-j} + \sum_{j=0}^{e} A_{4i}\Delta FDI_{t-j} + \sum_{j=0}^{f} A_{5i}\Delta GFCF_{t-j} \\ & + \sum_{j=0}^{g} A_{6i}\Delta LNLBR_{t-j} + \sum_{j=0}^{h} A_{7i}\Delta DCPSBB_{t-j} + \sigma ECT_{t-1} + \varepsilon_t \end{aligned} \tag{6}$$

Equations (5) and (6), Δ represent the difference operator and the error correlation term in Eq. (6) is σECT_{t-1}.

Results and discussions

Descriptive analysis

The Table 4 results are for the descriptive analysis, which shows the summaries of the variables employed. Economic growth (GDPG) averaged 4.3%, with the lowest being negative, -2%, and the highest being 15.3%. Trade openness (TOP) averaged 36.08% of GDP, ranging between 16.9% and 53.3% of GDP over the selected periods (1988-2022). Electricity production (EPP) averaged 29.3%, as high as 41.9% and as low as 17.6%. Foreign direct investment (FDI) averaged 1.6% of GDP, ranging between -0.03% and 5.8% of GDP over the periods. The country's capital formation (GFCF) averaged 30.04% of GDP, ranging between 14.9% and 53.2% over the periods covered. The total labour force (LBR) averaged about 49.1 million individuals, with the lowest being 32.8 million and the highest being 73.4 million. Bank credit to the private sector (DCPSBB) averaged 9.9% of GDP. It ranges between 4.95% and 19.6% of GDP over the periods covered. The variables are largely normally distributed, except for FDI, implying that their use in a parametric regression analysis is appropriate.

Furthermore, a plot of each variable is presented in Figure 3. This is necessary to view the movement of the time series variables examined. Trade openness (TOP), foreign direct investment (FDI), and GDP growth (GDPG) are fluctuating over the periods, signifying that they are reverting to their means and will likely be stationary when the unit root test is conducted. Electricity production (EPP) and gross fixed capital formation (GFCF) are trending downward, signifying that the values are reducing over time. The labour force is upward trending throughout the period, indicating that the labour force is consistently

Table 4. Descriptive statistics.

	Mean	Max	Min	Std. Dev	Jarque-Bera	*p*-value
GDP growth	4.307	15.32	−2.035	3.896	1.415	0.492
TOP	36.08	53.27	16.94	8.864	0.215	0.897
EPP	29.27	41.86	17.59	7.929	3.467	0.176
FDI	1.638	5.790	−0.039	1.273	24.14	0.000
GFCF	30.04	53.18	14.90	11.54	1.916	0.383
LBR	49,097	73,389	32,844	12,491	2.375	0.304
DCPSBB	9.953	19.60	4.948	3.541	4.250	0.119

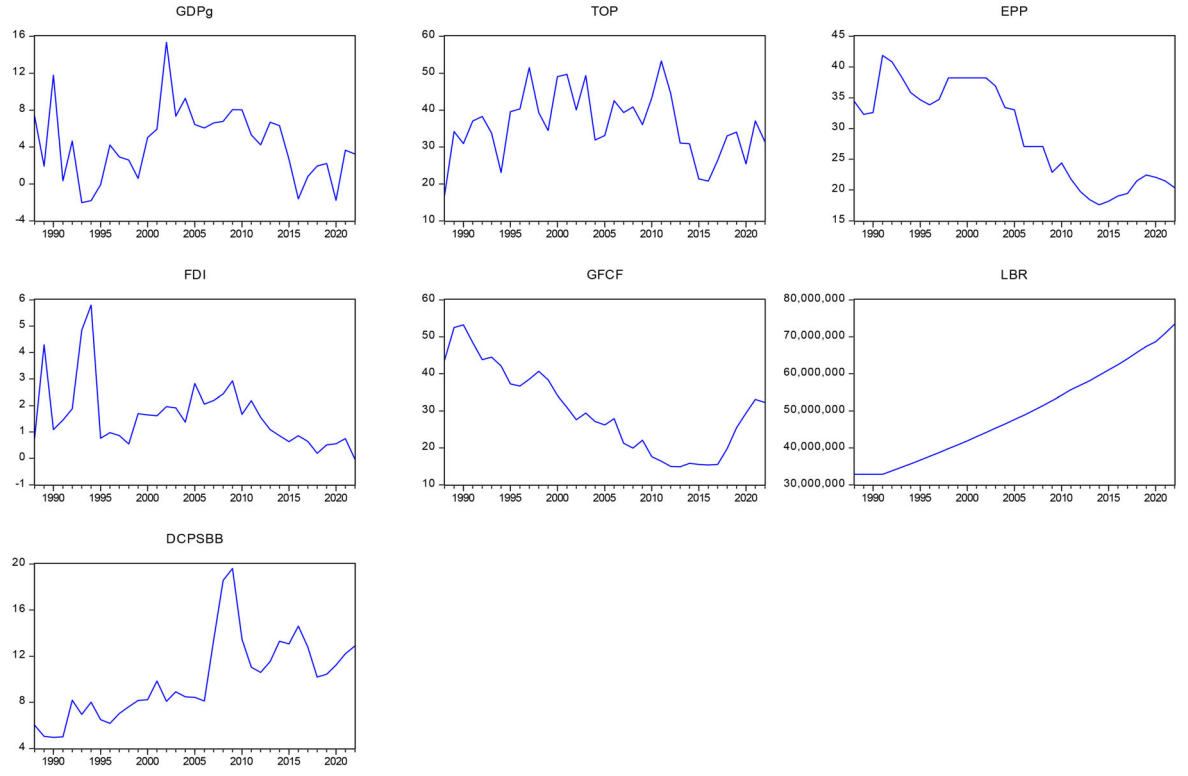

Figure 3. Time plots of variables.

increasing over the period under investigation. This consistent upward trend in the larger values of the labour force (in millions) relative to other variables necessitates transforming the variable into its natural logarithm form, which was used in subsequent analyses. Domestic credit to the private sector from banks (DCPSBB) also fluctuates slightly but exhibits an upward trend. Thus, EPP, GFCF, and DCPSBB may not be stationary when unit root test is carried out because of the trending nature of these series.

Correlation test

In addition to the descriptive statistics and trend analysis from time plot, a correlation matrix of the relationship among the variables was presented in Table 5. The matrix is necessary to verify if the variables (especially the explanatory variables) do not have a very high correlation that could cause multicollinearity problems in the regression estimates. The results revealed that the correlation between electricity production (EPP) and each of GFCF, log of the labour force (LNLBR) and DCPSBB is highly significant (at 1%). However, their correlation coefficients are less than 0.8, a threshold above which the correlation is deemed problematic. Similarly, the correlation between GFCF and each of the LNLBR and DCPSBB is highly significant (at 1%), but the correlation coefficient is lower than 0.8. Also, the correlation between the log of the labour force and DCPSBB is highly significant (at 1%); then again, the correlation coefficient is also lower than 0.8. Overall, this set of explanatory variables can be used together in a regression model without causing multicollinearity problems.

Unit root test

One of the earliest steps in time series analysis is to conduct a unit root test, which checks if the variables are stationary and suitable for regression analysis and predictions without further tests. Using both augmented Dickey-Fuller (ADF) (Dickey & Fuller, 1979) and Phillips-Perron (PP) (Phillips & Perron, 1988) proposed unit root tests, the results show a combination of stationary and non-stationary variable behaviour. The other advantage of using PP is that it caters to autoregression in the model (Pesaran & Shin, 1995; Yusuf et al., 2023). Specifically, EG, TOP, and FDI are stationary at their level series. At the same time, electricity production, capital formation, log of labour force and bank credit are not stationary at their level series but only become stationary at their first-difference series. Therefore, the former variables are stationary, and the latter are integrated series of order 1. This result implies that a further test is required to determine if these variables are appropriate for regression analysis without providing spurious results as shown in Table 6.

Table 5. Correlation matrix.

Variable	*GDPG*	*TOP*	*EPP*	*FDI*	*GFCF*	*LNLBR*	*DCPSBB*
GDPG	1.0						
TOP	0.283*	1.0					
EPP	0.069	0.290*	1.0				
FDI	−0.086	0.052	0.357**	1.0			
GFCF	−0.143	−0.018	0.755***	0.283*	1.0		
LNLBR	−0.108	−0.186	−0.768***	−0.473***	−0.737***	1.0	
DCPSBB	0.077	−0.080	−0.687***	−0.112	−0.752***	0.682***	1.0

Note. *** and ** signify significance at 1% and 5%.

Table 6. Unit root test.

	ADF test			PP test		
Variable	Level series	first difference series	Integration Order	Level series	first difference series	Integration Order
GDPG	−3.83***	–	I(0)	−3.74**	–	I(0)
TOP	−3.92**	–	I(0)	−3.94**	–	I(0)
EPP	−0.656	−5.239***	I(1)	−0.702	−5.242***	I(1)
FDI	−3.02**	–	I(0)	−3.74***	–	I(0)
GCFC	−2.479	−4.866***	I(1)	−1.295	−4.878***	I(1)
LNLBR	2.370	−3.392**	I(1)	1.639	−4.667***	I(1)
DCPSBB	−2.562	−5.352***	I(1)	−1.502	−6.415***	I(1)

Note. *** and ** signify significance at 1% and 5%.

Bounds test of cointegration

Given the combination of stationary and non-stationary variables identified by ADF and PP tests, a cointegration analysis with the bounds test procedure, as Pesaran et al. (2001) and Bertsatos et al. (2022) suggested, is deemed appropriate to ascertain whether a long-run relationship exists between the stationary and non-stationary variables. The cointegration test results revealed that the F-value 4.437 is higher than the I(1) critical bounds, even at a 1% significant level. It simply signifies that a statistically significant F-value from the bounds test confirms cointegration among the variables. Thus, this study's stationary and non-stationary variables have a long-term relationship. By implication, these variables can be used together in a multiple regression analysis without generating spurious regression results as shown in Table 7.

ARDL short and long run estimates

Given that there is evidence of cointegration, the next is to estimate an autoregressive distributive lag (ARDL) bounds model, which helps obtain short-run error correction and long-run estimates. As expected, and upheld by Banerjee et al. (1998), the lag of the error correction term had a negative and significant coefficient (−1.02, $p < 0.01$), which is approximately 1. This signifies that the model converges back to long-run equilibrium. Specifically, approximately all of the disequilibrium is corrected in each period. Furthermore, from the estimated results presented in Table 8, the lag values of the variables were removed from the short-run estimates for simplicity. In the short-run estimates, trade openness (TOP) had a positive but insignificant coefficient (0.015, $p > 0.1$); the result negates Sunde et al. (2023), Nwadike et al. (2020) and Tripathi (2023) findings and the export-led growth hypothesis. Electricity production (EPP) had a negative but insignificant coefficient (−0.285, $p > 0.1$) in relation to GDP growth, which aligns with Nchege and Okpalaoka (2023) findings. This means that lower electricity supply in Nigeria is associated with reduced economic growth, and it established the importance of electricity for GDP growth. However, the association is not strong enough to be considered statistically significant

Table 7. Bounds test cointegration procedure.

Test statistic			Critical value bounds					
			1%		5%		10%	
	Value	k	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
F-statistic	4.437***	6	3.15	4.43	2.45	3.61	2.12	3.23

Note. *** signifies significance at 1%.

Table 8. ARDL short and long run estimates.

Variable	Coefficient	Std. error	T	p-value
Short run				
Δ(TOP)	0.015	0.076	0.207	0.837
Δ(EPP)	−0.285	0.272	−1.047	0.308
Δ(FDI)	−1.540**	0.601	−2.561	0.019
Δ(GFCF)	0.045	0.206	0.218	0.829
Δ(LNLBR)	50.01	145.4	0.343	0.735
Δ(DCPSBB)	0.090	0.279	0.322	0.750
ECT(-1)	−1.02***	0.175	−5.863	0.000
Long run				
TOP	0.204**	0.080	2.541	0.020
EPP	0.649***	0.195	3.326	0.003
FDI	−1.497**	0.674	−2.219	0.039
GFCF	−0.199*	0.097	−2.053	0.054
LNLBR	5.993	5.702	1.051	0.307
DCPSBB	0.568**	0.266	2.136	0.046
Constant	−116.1	103.3	−1.123	0.276
Obs.	33			
R-squared	0.742			
Adj. R-squared	0.542			
F-statistic	3.71***			0.005

Note. ***, **, and * signify significance at 1%, 5%, and 10%.

within the study context. Foreign direct investment (FDI) had a negative and significant coefficient (−1.540, $p < 0.05$) on Nigeria's GDP growth in the short run. This corresponds with the result of Ayenew (2022) where FDI does not influence Sub-Saharans' economic growth in the short run.

Bank credit to the private sector (DCPSBB) had a positive but insignificant coefficient (0.090, $p > 0.1$) on GDP growth in Nigeria, suggesting that changes in DCPSBB do not have significant short-run implications for GDP growth. While this finding negates the *aprior* expectations and Adeusi and Oke (2013) study. It aligns with the results of Oluitan (2010) on bank credit and Amoo et al. (2017) private sector credit in Nigeria. This indicates that banks in Nigeria are not effectively channelling credit to businesses. Also, banks tend to offer short-term loans, which are misaligned with private firms' long-term needs. The inefficiency is further compounded by lax debt recovery processes and high interest rates on loans, which stifle investment and ultimately hinder economic growth. Gross fixed capital formation (GFCF) had a positive but insignificant coefficient (0.045, $p > 0.1$), and the log of the labour force (LNLBR) had a positive but insignificant coefficient (50.0, $p > 0.1$). This suggests that while these factors may contribute to economic growth over time, their immediate effect on GDP growth is limited. The insignificance could be due to the delayed impact of investments in physical capital (GFCF) and labour market improvements (LNLBR) on economic output. For instance, capital investments often take time to yield higher productivity and economic expansion, while changes in the labour force or labour policies require sustained implementation to manifest in economic growth. Since these variables are not statistically significant in the short-run analysis, the study emphasises the long-run results, where their potential contributions to growth might be more pronounced.

As for the long-run estimates, TOP, as expected, had a positive and significant coefficient (0.204, $p < 0.05$) on Nigeria's GDP growth. This confirms Esaku (2021) and Omoke and Opuala–Charles (2021) findings and establishes the pivotal role of trade liberation on economic performance. Importantly it conforms with the export-led growth hypothesis where increased market access boosts exports, resulting in economic growth (Dreger & Herzer, 2013; Islam & Alhamad, 2023). Electricity production had a positive and significant coefficient (0.649, $p < 0.01$); implying that a 1% increase in electricity production from the national grid might be associated with an increase of 0.649 percent points in Nigeria's GDP growth. Given that modern innovations and technologies heavily rely on electricity as the primary energy source. Electricity's positive and significant effect on GDPG aligns with the findings of Nchege and Okpalaoka (2023) and Lawal et al. (2020). It conforms with Nurkse (1953) theory on the importance of infrastructure development, particularly electricity, as a critical driver of economic growth, especially in developing nations like Nigeria. FDI had a negative and significant coefficient (−1.497, $p < 0.05$), indicating that a 1% increase in FDI causes a 1.5% fall in GDP growth in Nigeria. This finding is consistent with the empirical results of Khobai et al. (2018) and Musibau et al. (2024), which establish that FDI can hinder economic growth in Nigeria, as well as Tran et al. (2023), who argue that FDI could be a 'curse' to resource-exporting countries like Nigeria. However, this result contradicts the predictions of Solow-type neoclassical growth models (Alwafi, 2017; Brems, 1970), and the findings of Ayenew (2022) and Kumari et al. (2023), which suggest that FDI should increase a country's capital stock through financing capital formation, which fuels economic growth.

The GFCF had a negative and weakly significant coefficient (−0.199, $p < 0.1$), which negates Al-Harbi and Shaheen (2021) finding on Saudi Arabia, where capital formation was positively linked to economic growth and energy efficiency. This negative relationship in the current study may suggest inefficiencies in the use of capital or poor allocation of resources in Nigeria's economy, possibly due to structural issues or mismanagement in public investments. Similarly, the log of the labour force (LRLBR) had a positive but statistically insignificant coefficient (5.993, $p > 0.1$), indicating that while labour plays an important role in economic output, the immediate or long-term impact of changes in the labour force on Nigeria's GDP growth may not be strong enough to yield significant results. This could be due to underemployment, low productivity, or other labour market inefficiencies. DCPSBB had a positive and significant coefficient (0.568, $p < 0.05$), indicating that an increase in bank credit to private businesses has a strong positive effect on Nigeria's GDP growth. This suggests that the availability of credit allows businesses to invest in capital, expand operations, and improve productivity, all of which contribute to economic growth. The significance of this result highlights the critical role of financial institutions in driving private sector-led growth. As access to financing improves, firms can make longer-term investments, create jobs, and boost economic activities. This finding aligns with the empirical evidence from Duramany-Lakkoh et al. (2022) on Sierra

Leone and Onwioduokit and O'Neill (2023) on Nigeria, which posit that efficient allocation of credit fosters long-term economic growth by facilitating investment in productive sectors.

The results generally indicate that trade openness is influential in promoting economic growth in Nigeria only in the long term; electricity production is influential in promoting economic growth only in the long term; FDI is detrimental to economic growth both in the short and long runs; The explanatory variables DCPSBB enhances economic growth only in the long term; capital formation is weakly detrimental to economic growth in the long run; while labour force is not potent in promoting Nigeria's economic development both in the short and long terms. Moreover, the model also fits well with R-squared and adjusted R-squared values of 0.742 and 0.542, respectively, and has an F-statistic value of 3.71 with a p-value of 0.005.

Discussion of ARDL results

The TOP and economic growth results are particularly important given that Nigeria is one of Africa's largest economies, with crude oil exports making up 70% of its total exports (Khobai et al., 2018). Trade openness results confirm the *a prior* expectations that openness facilitates market liberalisation and provides crucial access to international markets, which is essential for Nigeria's economic expansion (Dreger & Herzer, 2013; Islam & Alhamad, 2023). The positive relationship between trade openness and economic growth suggests that fostering an open trade environment can lead to technological advancements and improve resource allocation efficiency (Omoke & Opuala–Charles, 2021; Sriyana & Afandi, 2020). As Nigeria continues integrating into the global economy, enhancing trade openness will be key to sustaining its economic growth and competitive edge in the international market.

The short-run findings indicate that insufficient electricity production profoundly impacts GDP growth and hinders Nigeria's overall development. This situation is particularly concerning given the country's poor state of electricity generation. Due to the unreliable supply from the national grid, many individuals and businesses have been forced to rely on their generators for power. This alternative is considerably more expensive than the electricity provided by the national grid, leading to higher production costs and, consequently, increased prices for goods and services. The economic repercussions of this energy crisis are far-reaching. Over 800 companies have relocated from Nigeria to countries with more reliable electricity supplies, and numerous others have shut down (Adenikinju, 2005; Egbichi et al., 2018). This exodus and closure of businesses highlight the critical need for a stable and sufficient electricity supply to maintain economic activities and support growth. The report underscores the severity of the issue by revealing that Nigeria requires 40,000 megawatts of electricity to meet its demands, yet the country currently only supplies 4,600 megawatts. This massive shortfall severely holds back the operations of manufacturing companies, which require around 2,500 megawatts but only have access to 267 megawatts (Apinran et al., 2022; Musibau et al., 2024; Statistics, 2022). The inadequate electricity supply leads to a significant decrease in the production of goods, negatively impacting trade and resulting in stunted economic growth. Considering these challenges, immediate and effective policy interventions are required to address the shortfall in electricity supply. These policies should focus on improving the infrastructure for electricity generation and distribution, encouraging investments in renewable energy sources, and enhancing the efficiency of existing power plants. By addressing these critical electricity issues, Nigeria can create a more conducive environment for economic growth, attract and retain businesses, and improve the living standards of its population.

FDI is detrimental to Nigeria's economic growth. FDI significantly and negatively affects economic growth in all the estimates. These include the negative inflow of external resources, which are crucial for financing development projects, creating employment opportunities, and facilitating technology transfer (Grossman & Helpman, 1991; Romer, 1990). Foreign investors are particularly interested in investing in Nigeria's electricity supply to ensure access to adequate and reliable power, essential for increasing productivity and fostering economic growth. The role of electricity in economic development cannot be overstated. A reliable electricity supply enhances productivity, boosting economic activities and growth. As productivity increases, it encourages trade openness, opening new markets and fostering international trade relations (Musibau et al., 2024; Ogudu et al., 2023). This interconnectedness benefits Nigeria by reducing trade barriers and integrating its economy with global markets. The study's findings on the relationship between explanatory

variable DCPSBB and GDP growth has a nuanced impact on Nigeria's growth. The current provision of credit to the private sector may not support immediate economic expansion, likely due to inefficiencies in the financial sector, high interest rates, or inadequate access to credit for productive investments. The insignificant impact of bank credit on the private sector in the short term could be attributed to factors such as high levels of non-performing loans, stringent lending conditions, or a lack of affordable credit for small and medium-sized enterprises (SMEs) (Adeusi & Oke, 2013; Amoo et al., 2017). However, in the long run, the positive and significant coefficient indicates that improvements in credit provision over time contribute to sustained economic growth (Duramany-Lakkoh et al., 2022; Onwioduokit & O'Neill, 2023). To address these short-term issues, policymakers should focus on enhancing the efficiency of the financial sector and implement regulatory reforms to address the attributed factors.

The capital formation and the labour force either contributed negatively or do not significantly contribute to Nigeria's GDP growth in the short and long term. This suggests that factors traditionally linked to economic growth, like infrastructure investments and workforce size, are underperforming in Nigeria. Several potential capitals are underutilised (investments bypassing productive areas, existing infrastructure like electricity underutilised), technological stagnation limiting the impact of capital investments, a skills gap between the workforce and job demands due to the education system not equipping workers with the right skills and structural bottlenecks like bureaucracy or lack of competition hindering overall efficiency. To address these challenges, a multi-pronged approach is crucial. First, boosting capital utilisation is essential. This means promoting technological advancement and innovation through research and development incentives. Second, fostering partnerships between businesses and educational institutions can bridge the skills gap. Third, investments in modern infrastructure that supports high-tech industries are vital. The labour market also needs an efficiency upgrade. Reforming the education system to focus on skills relevant to modern industries is critical, including updating curricula, expanding vocational training programs, and promoting lifelong learning opportunities. In addition, increasing job creation by supporting entrepreneurship and removing barriers to business development is crucial. The solution lies not in isolated fixes but in a comprehensive policy approach that considers financial sector efficiency (reducing non-performing loans, fostering competition among banks, and providing affordable credit) and coordinated efforts among government, private sector players, and international partners to address these multifaceted challenges.

Diagnostic statistics

To verify the validity and robustness of the regression results, this study follows Yusuf et al. (2023) and Islam et al. (2022) and carried out some diagnostic tests. These included the heteroskedasticity, serial correlation, normality, and stability tests reported in Table 9. Using the Breusch-Pagan-Godfrey heteroskedasticity test procedure, the study established that a heteroskedasticity problem is absent in the result, with an F-statistic of 0.712 and p-value of 0.737, which means that the statistic is insignificant and the test's Ho of homoskedasticity is accepted. Therefore, the residuals of the model have an equal spread. Employing the Breusch-Godfrey serial correlation test procedure established that the regression result is free from serial correlation problem given that the F-statistic has a value of 3.027 and a p-value of 0.076, which signifies that the test is insignificant (at 5%). Its Ho of no serial correlation is accepted. Also, the Jarque-Bera normality test statistic value of 0.361 and its p-value of 0.834 indicate that the normality statistic is insignificant, and its Ho of residual normality is not rejected; hence, the model residuals

Table 9. diagnostic Tests.

Breusch-Pagan-Godfrey Heteroskedasticity Test	
F-statistic	0.712
p-value	0.737
Breusch-Godfrey Serial Correlation LM Test	
F-statistic	3.027
p-value	0.076
Jarque-Bera Normality test	
Stat	0.361
p-value	0.834
Ramsey's RESET Stability test	
F-statistic	0.104
p-value	0.751

are normally distributed. Ramsey's RESET test was used to verify the stability of the model specification. Its F-statistic value of 0.104 and p-value of 0.751 signify correctly specifying the model.

Furthermore, the recursive residuals (CUSUM and CUSUM of Squares) methods were used to examine the stability of the model (Pesaran & Pesaran, 1997). From the CUSUM and CUSUM of squares plots in Figure 4, it was established that the model is stable. The CUSUM plot is shown to not diverge significantly from its zero-mean value, verifying the stability of the model. This is supported by the plot not falling outside the two red lines representing the 5% significance level. Similarly, the CUSUM of the squares plot is located within the red lines for all the periods considered, further buttressing the stability of the model. Overall, all the diagnostic tests indicate that the estimated model is valid for explaining the factors that determine economic growth, as shown in the result.

DOLS estimates

To validate the consistency of the findings, the Engle and Yoo (1989) dynamic ordinary least squares (DOLS) technique was employed as an alternative estimation method. This approach is particularly useful in addressing potential endogeneity and serial correlation issues, providing more reliable long-run estimates. The results, as presented in Table 10, indicate that trade openness (TOP) and electricity production (EPP) continue to exhibit a positive and statistically significant influence on Nigeria's economic growth, thus reinforcing the initial ARDL findings. These robust outcomes suggest that promoting trade liberalisation and enhancing electricity infrastructure should remain central to Nigeria's growth strategy. Foreign direct investment (FDI), on the other hand, still shows a negative coefficient in the DOLS model, but it is no longer statistically significant. This suggests that while FDI may not directly enhance economic growth, the negative impact observed in the ARDL model may be more nuanced, possibly influenced by institutional weaknesses or misalignment with growth-oriented sectors. This finding underlines the need for reforms aimed at improving the effectiveness of FDI in contributing to long-term development.

Furthermore, the negative influence of capital formation (GFCF) is confirmed in the robustness analysis, which points to inefficiencies in how capital is being utilised in the Nigerian economy. Labour force

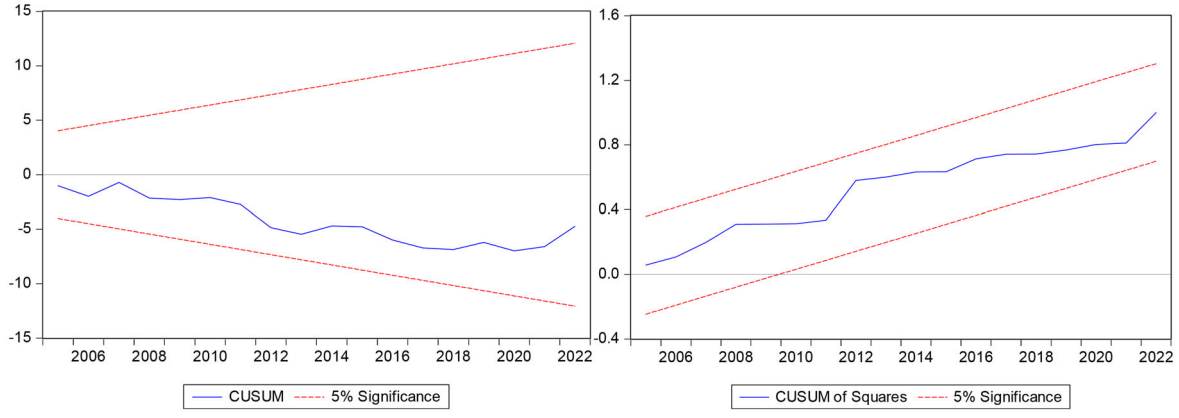

Figure 4. CUSUM and CUSUM of squares plots.

Table 10. Robustness estimate with dynamic OLS.

Variable	Coefficient	Std. Error	t	Prob
TOP	0.286***	0.060	4.747	0.002
EPP	0.984***	0.110	8.893	0.000
FDI	−1.177	1.033	−1.139	0.291
GFCF	−0.218**	0.092	−2.357	0.050
LNLBR	10.96*	4.687	2.340	0.051
DCPSBB	1.030**	0.388	2.652	0.032
C	−212.8	84.27	−2.525	0.039
Obs.	33			
R-squared	0.964			
Adj. R-squared	0.842			

Note. ***, **, and * signify significance at 1%, 5%, and 10%.

participation (LNLBR) was found to be significantly positive (10.96, $p < 0.1$), only in the DOLS robustness estimation, indicating that increases in the labour force can enhance GDP growth in Nigeria. The dynamic structure of the DOLS model is particularly effective in capturing long-term relationships and mitigating short-term fluctuations, which may explain why the effect of labour is more pronounced in this method compared to the ARDL. This result suggests that, in the long run, a growing labour force, combined with appropriate economic conditions, could significantly contribute to economic expansion. The finding is consistent with Islam (2021) and Islam et al. (2022) long-run ARDL results on Saudi Arabia. It also aligns with Neo-classical and labour-led growth theories (Khobai et al., 2018; Omoke & Opuala–Charles, 2021), which emphasise the importance of human capital in driving productivity and fostering future growth. In contrast, the positive impact of bank credit (DCPSBB) on economic growth remains robust across estimation techniques, highlighting the importance of financial sector development in driving growth. Overall, the DOLS robustness analysis solidifies the policy implications of the study, particularly the significance of trade openness and electricity production in fostering sustainable economic growth. These findings suggest that policy efforts should focus on improving trade conditions and addressing electricity generation challenges to stimulate long-term growth.

Conclusion and policy recommendations

This study investigates the impact of trade openness, hydroelectric power production, and FDI on Nigeria's economic growth from 1988 to 2022, using the ARDL bounds model and DOLS to assess both long-term and short-term relationships. The findings confirm that trade openness positively influences Nigeria's economic growth in both the long run and the DOLS estimates. In contrast, electricity production has a notably positive effect on long-term growth and in DOLS but shows a negative and insignificant impact on GDP growth in the ARDL short-term estimate. Nigeria's electricity infrastructure characteristics might have contributed to the mixed result. FDI, while significant in both the short and long-run ARDL estimates, consistently exhibits a negative relationship with economic growth. This suggests that FDI is not contributing effectively to the country's growth, potentially due to inefficient resource allocation, institutional weaknesses, or inadequate infrastructure. These findings underline the importance of creating policies that address these structural challenges to better leverage FDI for economic development. The study also incorporates control variables such as capital formation, labour, and bank credit to private sectors to ensure robustness. These variables provide additional insights into the drivers of growth beyond the baseline variables.

Hence, the following recommendations are proposed based on the findings of this study: Firstly, to enhance international trade and economic growth, the government should prioritise eliminating trade barriers like tariffs and quotas. In addition, policymakers and stakeholders should focus on simplifying customs procedures, improve logistics, and ensure a stable economic environment for smoother trade relations with other countries. As enhancing trade competitiveness is essential for boosting growth and integration into global markets. Secondly, the government must focus on a two-part plan to guarantee a consistent, reliable and efficient electricity supply. This involves repairing and upgrading faulty hydroelectric power infrastructure and investing in modern technologies to expand and improve the national grid. Electricity is the primary energy source enabling mass production and is essential for exports and domestic consumption. Thirdly, the government should create a conducive environment for foreign investors, particularly in Nigeria's electricity sector, as external resources are required to implement its projects. External resources are crucial for development and economic growth, providing capital, technology, and expertise essential for progress. By attracting FDI, a country can access the necessary tools to enhance its electricity infrastructure, support industrial growth, and drive overall development.

Lastly, while this study focuses on trade openness, electricity production, and FDI, it excludes other potentially influential factors like institutional quality, environmental factors, technological advancements, and the sectoral impacts of electricity and foreign investment. Future research could explore the limitations to provide a more nuanced view of Nigeria's economic growth for practical policy recommendations.

Note

1. For a detailed discussion on energy use in Nigeria, see Musibau et al. (802024).

Disclosure statement

No potential conflict of interest was reported by the author(s).

Author's contributions

Author contributions: Conceptualization, GKL and FT; methodology, GKL; formal analysis, GKL; data curation, GKL; writing—original draft preparation, GKL; writing—review and editing, GKL and FT; supervision, FT; project administration, FT. All authors have read and agreed to the published version of the manuscript.

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Data availability statement

The data supporting the findings of this study are readily accessible, as stated in the data sources above.

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