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INFRASTRUCTURE, TRADE EXPANSION, AND INCLUSIVE GROWTH IN NIGERIA: EVIDENCE FROM ARDL ANALYSIS

Gbenro Matthew Sokunbi

Department of Economics Education, Lagos State University of Education
Ijanikin, Lagos Nigeria

Email: sokunbigm@lasued.edu.ng

ABSTRACT

Despite Nigeria's significant economic size, growth has not consistently translated into broad-based welfare improvements due to persistent poverty, inequality, and sectoral imbalances. This study investigates the role of infrastructural development, disaggregated into transport, energy, and ICT, in fostering trade expansion and promoting inclusive growth in Nigeria. Using annual data from 1995 to 2024 and applying an ARDL modeling framework, the analysis uncovers a stable long-run relationship among infrastructure investment, trade openness, macroeconomic stability, and economic growth. The findings indicate that infrastructure-led trade expansion significantly contributes to growth; however, its ability to generate inclusive outcomes is contingent on sectoral composition, spatial distribution, and institutional quality. Deviations from long-run equilibrium are corrected rapidly, highlighting the economy's responsiveness to infrastructure and trade policy interventions. The study underscores that while infrastructure and trade are necessary drivers of inclusive growth, policy design must prioritize economic relevance, domestic firm capacity, and institutional coordination. Findings provide evidence for policymakers to align infrastructure and trade strategies with employment creation, regional balance, and SME support, ensuring that economic gains translate into widespread prosperity.

Keywords: Inclusive growth, Infrastructural Development, Trade Expansion, Inclusive Growth

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1. Introduction

Despite Nigeria's status as one of Africa's largest economies, a growing body of literature highlights that economic growth has not translated into broad improvements in living standards due to persistent poverty and inequality. Empirical analyses show that income inequality has weakened the poverty-reducing impact of growth, with poverty rates remaining high even during periods of expansion (Apanisile et al., 2025; Olasode et al., 2022). World Bank poverty assessments indicate that over 40% of Nigerians live in extreme poverty and that multidimensional poverty affects an even larger portion of the population, underscoring the disconnect between aggregate GDP gains and household-level welfare improvements (World Bank, 2025). This disconnect between growth and welfare has sharpened focus on inclusive growth. That is growth that is broad-based, equitable, and ensures that vulnerable groups are not left behind (Anand et al. 2013).

A critical lever in this quest is infrastructure. Transport, energy, and digital infrastructure reduce transaction and logistical costs, improve access to markets and services, and enable firms, especially smaller and informal ones, to compete more effectively. Empirical work for Nigeria supports this: Wahab (2024) finds that both transport and ICT infrastructure significantly influence bilateral trade flows with Nigeria's trading partners, with transport infrastructure having a greater effect on exports and ICT playing a somewhat larger role in imports. Nigeria's chronic power shortages (Eboh, 2024), dilapidated roads, congested ports, and inadequate ICT networks hamper trade, limit productivity, and raise costs, particularly for non-oil sectors.

Trade expansion is seen as the transmission channel through which infrastructure can generate inclusive outcomes. When infrastructure lowers barriers, trade volumes tend to increase, facilitating export growth, import of inputs, and integration into regional or global value chains. These help to generate jobs, increase incomes, and reduce poverty, if the gains are widely shared. However, not all trade expansion is equally beneficial. Sectors that are labour-intensive and geographically dispersed tend to deliver more inclusive outcomes than capital-intensive ones or those concentrated in specialized or urban settings.

In Nigeria, though, trade expansion has been heavily skewed. The oil sector remains dominant in export earnings, but generates few jobs and contributes to minimal poverty alleviation owing to its capital-intensive nature. Attempts to diversify into agriculture, manufacturing, and services confront substantial infrastructural bottlenecks, poor institutional quality, and limited competitiveness among SMEs. Institutional weaknesses, such as regulatory inefficiencies, corruption, or poor contract enforcement, may reduce or misallocate the returns from both infrastructure investment and trade liberalisation.

Recent empirical studies sharpen the understanding of these dynamics. For example, Wahab (2024, uses a gravity model with instrumental variables to show that transport infrastructure strongly influences Nigeria's export performance, while ICT has larger marginal effects in import channels. Also, Ajayi et al. 2024, finds

that while trade openness enhances inclusive growth over the long run, its interaction with institutional infrastructure is negative and statistically insignificant. This suggests that institutional frameworks may not yet sufficiently support the translation of trade expansion into broad-based welfare improvements.

Nigeria's policy environment has recently registered signs of momentum. The May 2025 Nigeria Development Update from the World Bank reports that economic growth rose to 4.6% year-on-year in the final quarter of 2024, pushing full-year growth to an estimated 3.4%. Reforms to improve fiscal positions, strengthen foreign exchange operations, and stimulate revenue have opened some fiscal space. However, the report cautions that accelerating inclusive growth will require deeper structural reforms, particularly in infrastructure, human capital, and social protection. (World Bank, 2025)

Investments already underway underscore the stakes. Nigeria has secured a US\$600 million investment from A.P. Moller-Maersk to upgrade port infrastructure, targeting automation and modernization to ease congestion and reduce trade-costs. A US\$1.3 billion rail link between Kano and Maradi (Niger Republic) aims to bolster trade and cross-border connectivity while improving transport infrastructure in the north (Reuters, 2024). These are examples of infrastructure projects that have the potential to enhance trade expansion, if complemented by inclusive policies.

Despite the promise, several empirical gaps remain. First, many studies focus on aggregate GDP as the outcome of infrastructure and trade, leaving inclusive growth (as measured by poverty reduction, income share of the bottom 40%, employment formation, and regional disparities) underexamined. Second, trade expansion as an explicit mediating channel between infrastructure and inclusiveness is understudied. Third, the heterogeneous effects of different infrastructure components (roads vs ports vs ICT vs energy) and their spatial distribution (urban vs rural, core vs periphery) are seldom disentangled in Nigeria. Fourth, institutional quality is often assumed but not sufficiently measured or included to assess how it conditions the infrastructure-trade-inclusive growth nexus.

This study, therefore, aims to fill these gaps by disaggregating infrastructure into transport, energy, and ICT; examining their impacts on trade expansion; and tracing how trade gains feed into inclusive growth outcomes. Employing robust econometric techniques (instrumental variables, panel methods) to account for endogeneity, the study will explore direct and indirect (mediated) effects. By doing so, it seeks not only to assess the magnitude of impacts but to uncover which infrastructure types and policies are most promising for Nigeria's inclusive development goals.

The question Nigeria currently faces is not whether more infrastructure and trade are beneficial; they clearly are, but how to design, distribute, and govern them so that all Nigerians benefit. As the country engages with AfCFTA, builds ports, railways, and digital networks, and reforms institutional structures, evidence

on what works will be crucial for turning growth into shared prosperity. Thus, the research questions and objectives for this study are provided below:

Research Questions:

- a) What is the effect of transport, energy, and ICT infrastructure on trade expansion in Nigeria?
- b) To what extent does trade expansion, driven by infrastructural development, promote inclusive growth in Nigeria, given existing sectoral and institutional conditions?

Objectives of the Study:

- a) To examine the effect of disaggregated infrastructural development (transport, energy, and ICT) on trade expansion in Nigeria.
- b) To assess how infrastructure-induced trade expansion contributes to inclusive economic growth in Nigeria, conditional on sectoral composition and institutional quality.

2. Literature Review

2.1 Conceptual literature

Infrastructure has increasingly been recognised as the backbone of economic transformation, trade expansion, and inclusive growth, with scholars conceptualising it in both narrow and multidimensional forms. Early accounts framed infrastructure as the physical and communications backbone that facilitates trade flows through transport networks and telecommunications systems (Francois & Manchin, 2013). Within this framing, accessibility and reduction in transaction costs are central, as highlighted by Crescenzi and Rodríguez-Pose (2012), who treated motorway density as a proxy for infrastructure investment aimed at territorial cohesion. Similarly, Ng et al. (2019) focused on road length expansion per population as a means of enhancing mobility, efficiency, and trade facilitation. From a developmental perspective, infrastructure is more than a physical stock: it is an exogenous factor of production that reduces costs, enhances competitiveness, and improves access to opportunities (Verico & Qibthiyyah, 2023). This broader framing encompasses both tangible assets and institutional frameworks, a view echoed by Serebrisky (2014), who linked infrastructure to productivity, social welfare, and sustainability.

Recent scholarship has extended conceptualisation beyond physical capital to service-based and multidimensional proxies. Ofori et al. (2024) distinguished between physical and digital infrastructure, while Aluko and Ngubane (2024) operationalised infrastructure using proxies such as electrification, sanitation, ICT access, transport usage, and school enrolment, thereby capturing its influence on human

development outcomes. Bhattacharya et al. (2020) reinforced this perspective by conceptualising infrastructure as sectoral capital in electricity, roads, education, and health. In contrast, earlier approaches such as Ansar et al. (2016) and Babatunde (2018) maintained a traditional view of infrastructure as large-scale public capital expenditure designed to catalyse production and human capital development. These perspectives reveal an evolution from a narrow stock-based view to a multidimensional conception that integrates inclusivity, sustainability, and welfare outcomes.

Within this framework, trade-related infrastructure emerges as a critical channel linking infrastructure development to trade expansion. Wahab (2024) defined trade-related infrastructure as physical and digital systems that reduce trade costs, facilitate cross-border participation, and enhance competitiveness, while Ouni et al. (2025) highlighted transport and ICT as essential drivers of market access. Chen and Kuang (2023) further introduced the notion of sustainable infrastructure, emphasising investments that build resilience and expand equitable participation in global trade systems. Inefficient infrastructure, conversely, raises transaction costs and restricts integration into global value chains, a challenge particularly evident in Nigeria.

Inclusive growth, the ultimate welfare outcome of infrastructure and trade expansion, has been framed as economic growth that is equitable, broad-based, and pro-poor. Ofori et al. (2024) and Mutiiria, Ju, and Dumor (2020) stress its distributive nature, while Liu et al. (2023) operationalised it through the Inequality-adjusted Human Development Index (IHDI). Recent perspectives situate inclusive growth as a corrective to the inadequacies of trickle-down economics. Wugah et al. (2025) conceptualise it as growth that directly reduces poverty and inequality, while Randa (2024) highlights the balance between monetary and non-monetary gains. Within the Nigerian context, inclusive growth has also been tied to the productivity and participation of domestic industries. Kodzi (2023), for instance, situates it within the Belt and Road Initiative, underscoring cooperative linkages that promote sustainable value addition and employment generation.

Synthesising these perspectives, infrastructural development underpins trade expansion by reducing costs and enhancing connectivity, while trade creates opportunities that must be equitably distributed to achieve inclusive growth. For Nigeria, where infrastructural deficits persist, the key challenge lies in aligning infrastructure investment not only with efficiency goals but also with distributive outcomes. Integrating transport, ICT, and social infrastructure within inclusive trade frameworks can generate the synergies needed to transform growth into broad-based human development, reduce inequality, and foster long-term sustainability.

2.2 Theoretical Literature:

The interconnection among infrastructural development, trade expansion, and inclusive growth in Nigeria can be examined through the New Growth Theory and the Inclusive Growth Theory. The New Growth Theory highlights that long-term growth is driven not only by physical capital and labour but also by endogenous factors such as knowledge, innovation, and infrastructural investment (Romer, 1994; Aghion & Howitt, 1998). Infrastructure is considered a central growth-inducing mechanism, as it lowers transaction costs, enhances productivity, and facilitates market integration. Liu, Li, and Yang (2023) emphasise that strategic infrastructural investments strengthen productive capacity by addressing bottlenecks in energy, transport, and ICT, particularly in developing economies where such deficits are growth-constraining.

In complement, the Inclusive Growth Theory asserts that growth must be broad-based and equitably distributed to reduce inequality and foster welfare improvements. Kakwani and Pernia (2000) argue that growth should be deliberately structured to expand opportunities, moving beyond the “trickle-down” approach. Empirical evidence in Nigeria reveals that periods of high growth have often coincided with inequality and unemployment (Ajakaiye & Adeyeye, 2001; Ngepah, 2017). Infrastructure thus becomes not only an economic asset but also a social equaliser, improving access to markets, healthcare, and education (Mutiri, Ju, & Dumor, 2020). Aluko and Ngubane (2024) stress that infrastructure reduces barriers to human development, while Randa (2024) underscores the role of financial and physical infrastructures in enhancing institutional governance and expanding opportunities.

Trade expansion provides an additional link between these theories, as improved infrastructure enables specialization, knowledge spillovers, and integration into global value chains (Grossman & Helpman, 1991). In Nigeria, infrastructural deficits in ports, transport, and electricity constrain competitiveness, but investments in trade-related infrastructure reduce costs and stimulate diversification (Wugah, Tersoo, & Oladipo, 2025). Wahab (2024) demonstrates that transport and ICT infrastructure significantly improve Nigeria’s bilateral trade flows, reinforcing the theoretical claim that infrastructural development is pivotal for both trade and inclusive growth.

Collectively, these theories affirm that infrastructural development is inseparable from inclusive growth objectives. For Nigeria, addressing infrastructural gaps is central to trade expansion, competitiveness, and achieving equitable development outcomes.

2.3 Empirical Literature

The growing consensus from existing studies positioned infrastructure as an indispensable lever for enhancing productivity, lowering trade costs, and promoting shared prosperity. However, evidence remains heterogeneous across regions, sectors, and methodological designs, raising questions about the

conditionality of infrastructural effectiveness and its capacity to generate inclusive outcomes. Ofori et al. (2024) provide a compelling investigation into the contingency effect of infrastructure on the relationship between foreign aid and inclusive growth in Sub-Saharan Africa (SSA). Using dynamic system generalised method of moments (GMM) estimation on macroeconomic data for 41 SSA countries (2003–2020), their study shows that while foreign aid significantly enhances inclusive growth, the effect of infrastructure is mixed. Transport infrastructure exerts a strong positive effect, amplifying the aid-growth nexus, while energy, sanitation, and digital infrastructure are statistically insignificant. Importantly, they highlight threshold effects: 22% digital and 57.8% transport infrastructure coverage are necessary before synergistic complementarities occur. Their findings emphasise the importance of physical connectivity, particularly in transport, for realising inclusive growth in aid-dependent economies.

In a similar vein but with a more country-specific orientation, Wahab (2024) examines the impact of trade-related infrastructure on Nigeria's bilateral trade flows with 22 major partners (2005–2021). Employing an augmented gravity model estimated via pooled two-stage least squares (2SLS) with instrumental variables, the study disaggregates between transport and ICT infrastructure, drawing on WDI, UNCTAD, and ITC datasets. Results reveal that transport infrastructure exerts a stronger impact on exports, whereas ICT infrastructure influences imports more robustly. These findings suggest that Nigeria's integration into global markets requires a balanced strategy, expanding roads, ports, and air networks to boost exports, while simultaneously investing in ICT penetration to facilitate import efficiency. Compared with Ofori et al. (2024), the analysis underscores infrastructure's dual role: a direct enabler of trade and an indirect catalyst for inclusivity through global market integration.

The contextual importance of disaggregating transport sub-sectors is further highlighted by Liu, Ling, and Chen (2023), who studied 20 countries between 2010 and 2021. Using fixed-effects regression and IHDI as a proxy for inclusive growth, they find that rail transport consistently promotes inclusivity, while air passenger transport has no significant effect. Air freight enhances inclusive growth in developing countries but reduces it in advanced economies, and port infrastructure benefits inclusivity only in developed contexts. Their findings tinge Wahab (2024) by showing that transport infrastructure's effects are not homogeneous across contexts, calling for country-specific assessments.

Infrastructure is not limited to the physical sphere; financial infrastructure also plays a critical role. Randa (2024), using an interpretivist paradigm based on secondary documentary analysis, shows that financial infrastructure development enhances inclusivity by catalyzing savings, expanding credit, and strengthening institutional trust in SSA. Unlike Wahab (2024), who emphasises hard infrastructure's role in trade, Randa demonstrates that soft infrastructure in financial systems complements physical networks by deepening access, fostering entrepreneurship, and reducing exclusionary barriers.

Country-specific time-series studies provide further perceptions about the infrastructure's poverty-alleviating capacity. Fagbemi et al. (2022), analysing Nigeria between 1996–2019 with ARDL and VECM-based Granger causality, find that infrastructure investment significantly reduces poverty and that a bidirectional long-run causality exists: infrastructure promotes poverty reduction, while poverty reduction enhances efficient public sector allocation. Similarly, Chen and Kuang (2023), using GMM across Asian countries (2000–2020), show that infrastructure, particularly energy and water access, directly reduces poverty, while inclusive growth amplifies these effects. Both studies converge in demonstrating that the relationship between infrastructure and poverty is bidirectional, contrasting with Ofori et al. (2024), who report asymmetries in infrastructure's role depending on subsector.

However, evidence is not universally supportive of infrastructure-led growth. Ansar et al. (2016), using project-level cost–benefit analysis of 95 Chinese road and rail projects (1984–2008) against 806 projects in advanced democracies, reveal systemic inefficiencies: cost overruns, benefit shortfalls, and debt accumulation undermined infrastructure's growth impact. Their findings question the assumption that infrastructure is inherently growth-enhancing, contrasting sharply with Fagbemi et al. (2022) and Wahab (2024), who found positive effects in Nigeria. This divergence underscores the importance of investment quality and institutional efficiency, echoing Crescenzi and Rodríguez-Pose (2012), whose study of 120 EU regions (1990–2004) finds infrastructure endowment a weak predictor of growth once innovation and socio-institutional conditions are included.

The interplay of trade, finance, and inclusivity is further developed in Wugah et al. (2025), who use system GMM for 27 SSA economies (2008–2021). Their findings reveal that trade enhances inclusive growth, but local financial market weaknesses diminish benefits, with unregulated private sector credit proving ineffective. This resonates with Randa (2024), who emphasises the role of robust financial infrastructure, and contrasts with Wahab (2024), who stresses physical infrastructure in shaping Nigeria's trade outcomes.

The global evidence base also highlights complementarities between road infrastructure and trade. Ng et al. (2019), analysing 60 countries (1980–2010) with fixed-effects regression, show road expansion enhances exports and, alongside human capital and capital stock, drives growth. Their inverted U-shaped finding on urbanisation suggests that infrastructure–growth effects may taper in overly urbanised contexts. This complements Serebrisky (2014), who, focusing on Latin America, shows that infrastructure lowers logistics costs, enhances competitiveness, and improves social inclusion.

Evidence from Indonesia (Verico and Qibthiyyah, 2023) and India (Bhattacharya et al., 2020) extends the discourse by adopting multidimensional measures. The Indonesian case uses Okun's Law, Phillips Curve, and output gap frameworks to show that infrastructure boosts GDP contribution and reduces inequality, but with delayed inclusivity effects due to cost–benefit time lags. Similarly, Bhattacharya et al. (2020) use

PVAR for Indian states (2004–2016) to show that infrastructure improves growth and reduces poverty, particularly through electricity, education, and health access. Their multidimensional focus echoes Aluko and Ngubane (2024), who, analysing five emerging economies (2005–2019) via dynamic panel modelling, find water, sanitation, and electrification significantly boost HDI, while ICT and transport have weaker effects. These findings collectively caution against one-size-fits-all infrastructure prioritisation, calling for nuanced, sector-specific strategies.

Cross-continental studies deepen the inclusivity narrative. Ouni et al. (2025), using FMOLS, DOLS, AMG, and CCEMG for 33 developing economies (1995–2021), demonstrate that transport infrastructure and inclusive growth jointly reduce poverty, with bidirectional causality confirmed. Similarly, Mutiiria, Ju, and Dumor (2020), using an inclusive growth index for 31 SSA countries (2003–2017), show energy, transport, and ICT infrastructure disproportionately benefit poorer households, underscoring redistributive effects.

Nigeria-specific perceptions are further offered by Babatunde (2018), who employs both econometric (unit root, WLS, VECM) and survey-based approaches (242 Lagos respondents). The findings show that government spending on transport, communication, education, and health infrastructure promotes growth, but agricultural and natural resource spending reduces it, reflecting inefficiency and crowding-out. This contrasts with Fagbemi et al. (2022), whose broader measure of infrastructure investment finds a uniformly positive poverty-reducing role, highlighting that sectoral allocation critically determines outcomes.

Finally, studies on the global political economy of infrastructure, such as Kodzi (2023), who interrogates Chinese FDI under the Belt and Road Initiative, reveal that infrastructure-led investment may enhance macroeconomic performance but undermine domestic industry linkages. This echoes Ansar et al. (2016) and Crescenzi & Rodríguez-Pose (2012) in underscoring that without institutional strengthening, infrastructure alone risks producing dependency or inefficiency rather than inclusive growth.

Taken together, these studies converge on the critical role of infrastructure - physical, digital, and financial- in enabling trade expansion and inclusive growth. Yet, divergences persist regarding which types of infrastructure matter most, under what institutional conditions, and across what time horizons. Nigeria-focused evidence (Babatunde, 2018; Wahab, 2024; Fagbemi et al., 2022) consistently shows that infrastructure enhances growth and reduces poverty, but sectoral inefficiencies and allocation biases undermine its potential. Comparative evidence (Ansar et al., 2016; Crescenzi & Rodríguez-Pose, 2012) warns that infrastructure effectiveness is contingent on governance quality, innovation, and absorptive capacity.

This study is therefore motivated to examine the relationships among infrastructural development, trade expansion, and inclusive growth in Nigeria.

3. Methodology

This study examines the relationship among inclusive economic growth, infrastructure development, and trade openness in Nigeria using annual time-series data from 1995 to 2024. The empirical model is adapted from Celik et al. (2024) and specified as:

$$GDPgr = f(INFRS, TRO, INFR) \quad (1)$$

Equation 1 is a mathematical expression of the functional relationship between inclusive economic growth proxied by economic growth, infrastructure, trade openness, and inflation rate.

The econometric form of the regression model is stated as follows:

$$GDPgr = \beta_0 + \beta_1 INFRS + \beta_2 TRO + \beta_3 INFR + \mu_t \quad (2)$$

in equation 2, GDPgr captures the inclusive economic growth, INFR captures the infrastructures measured by the capital expenditures on infrastructures, TRO captured the trade openness measured by the index ratio of volume of export to volume of import, and INFR captured the inflation rate the control variable and intercept parameter estimate is represented by β_0 indicates the intercept, β_1 , β_2 , and β_3 represent the parameter estimates of various independent variables, and μ_t represents the error term. The estimation focuses on the sign of the coefficients of independent variables and their corresponding values.

To determine the long-run estimate of the coefficient of ARDL, it is necessary to determine the ρ maximum lag order of the ARDL model (p1,q1,q2,q3,q4). The long-run model for Y_t (GDPgr) was estimated as:

$$GDPgr = \delta_0 + \sum_{\rho=1}^{\rho} \delta_1 GDPgr_{\rho=1} + \sum_{\rho=1}^{\rho} \delta_2 INFRSE_{\rho=1} + \sum_{\rho=1}^{\rho} \delta_3 TRO_{\rho=1} + \sum_{\rho=1}^{\rho} \delta_4 INFR_{\rho=1} + \eta_t \quad (3)$$

However, to obtain the short-run dynamic parameters by estimating an error correction model associated with the long-run estimates, the model is specified as:

$$GDPgr_{t=\tau} = \delta_1 \sum_{\rho=1}^{\rho} \Delta INFRS_{\rho=1} + \beta_1 \sum_{\rho=1}^{\rho} \Delta TRO_{\rho=1} + \theta \sum_{\rho=1}^{\rho} \Delta INFR_{\rho=1} + \tau_1 ECM_{t-1} + \tau_2 t \quad (4)$$

Where Δ implies the differences of the variables.

In equation 4, ECM_{t-1} is the lagged error correction term, which is the speed of adjustment, while θ , σ , and β are the short-run dynamic coefficients of the model's convergence to the point of equilibrium. The appropriate lag structure of ECM is determined by the Akaike information criterion (AIC).

Table 1: Description of Variables

Variable	Code	Definition	Source
Inclusive economic growth	GDPgr	GDP (annual growth rate%)	WDI

Infrastructures	INFRS	Infrastructure is measured by capital expenditures on transport, communication, roads, etc.	CBN
Trade Openness	TRO	Trade openness is measured by taking the ratio of the index volume of exports and imports.	WDI
Inflation rate	INFR	Inflation rate	WDI

Source: Author's compilation (2025)

The estimation procedure begins with an assessment of the stationarity properties of the variables, as the use of non-stationary time-series data may lead to spurious regression outcomes. Accordingly, the Augmented Dickey–Fuller (ADF) unit root test is employed to determine the order of integration of each series. Based on the stationarity results, a cointegration analysis is subsequently conducted to examine the existence of a long-run equilibrium relationship among the variables. Given that the variables exhibit mixed orders of integration, the autoregressive distributed lag (ARDL) bounds testing approach is adopted, as it is suitable for variables integrated of order $I(0)$ and $I(1)$ and remains robust in small sample settings. Upon confirmation of cointegration, the ARDL model is estimated to capture both the long-run relationships and short-run dynamics, while the associated error-correction term provides insight into the speed at which deviations from long-run equilibrium are corrected.

4. Result and Discussion

4.1 Result

Table 2 shows the ADF test result, which is a test for stationarity (unit root) of the variables employed in this study. On the other hand, the ARDL bound test for cointegration was used to check the existence of a long-run relationship among the variables used in this paper. The ARDL bound test compares the calculated F-statistic to the lower and upper bound table values at a chosen level of significance. If the F-statistic is greater than the upper bound value, then we can conclude the variables are cointegrated (that is, they are all integrated of $I(1)$).

The ADF unit root test reveals that all the variables in this study are stationary at only the first difference. GDP growth rate (GDPgr) and inflation rate (INFR) were stationary both at the level and first difference, while trade openness (TRO) and infrastructure (INFRS) are stationary at only first difference ($I(1)$). This validates the use of the ARDL bound test to confirm if all variables are stationary at $I(1)$ and cointegrated.

Table 3, which entails the ARDL bound test result, indicates that all variables used in this paper are cointegrated at I(1) because the F-stat value is greater than the upper bound value at 1%, 2.5%, 5% and 10% significance levels. This signifies that there is a long-run relationship between the variables. Alternatively, this means that GDPgr, INFRS, INFR, and TRO are all I(1) and cointegrated.

Table 2: Augmented Dickey Fuller (ADF)

VARIABLES	Augmented Dickey Fuller (ADF) (Prob values)				Order of Integration
	Level		1 st Difference		
	Critical value	T-Stat	Critical value	T-stat	
GDPgr	-3.007795	-2.967795	-7.748805	-3.689196	I(0) and I(1)
INFRS	2.747243	-3.679322	-3.981295	-3.689194	I(1)
INFR	-8.536991	-3.679322	-7.020590	3.689194	I(0) and I(1)
TRO	-1.336533	-3.689194	-7.020590	-3.689194	I(1)

Source: Author's compilation (2025)

Table 2 presents the results of the Augmented Dickey–Fuller (ADF) unit root tests used to examine the stationarity of the variables. The findings show that the variables are stationary at different levels. GDP growth is stationary at both the level and first difference, indicating that it is relatively stable over time but also reacts to short-term changes. Infrastructure spending is non-stationary at the level but becomes stationary after first differencing, suggesting that it follows a long-term trend. The inflation rate is stationary at a level and remains so after differencing, implying that inflation fluctuations tend to return to their long-run path. In contrast, trade openness is non-stationary at the level but stationary at the first difference, indicating that changes in trade openness are persistent over time. The presence of a mix of I(0) and I(1) variables supports the use of the ARDL approach, which is suitable for estimating both short-run and long-run relationships under such conditions.

Table 3: ARDL Bound Test Result

Test Statistic	Value	k
F-statistic	4.277269	3
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.72	3.77

5%	3.23	4.25
2.50%	3.69	4.89
1%	4.29	5.61

Source: Author's compilation (2025)

Table 2 reports the ARDL bounds test for cointegration with three regressors ($k = 3$). The computed F-statistic is 4.277. This value is higher than the upper bound (I1) at the 5% (4.25) and 10% (3.77) significance levels. However, it is slightly below the 1% upper bound (5.61) and marginally below the 1% lower bound threshold.

Following the decision rule of Pesaran et al. (2001), when the F-statistic exceeds the upper bound, the null hypothesis of no long-run relationship is rejected. Therefore, the result provides strong evidence of cointegration at the 5% level. This implies that the dependent variable and the explanatory variables move together in the long run, despite possible short-run fluctuations. Consequently, estimating both the long-run coefficients and the associated error-correction model (ECM) is therefore justified.

Table 4: VAR Lag Length Selection Criteria for INFRS, INFR, and TRO

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-503.1793	NA	1.91e+09	32.72125	32.90628	32.78156
1	-419.0586	141.1057*	23824408*	28.32636*	29.25152*	28.62794*
2	-409.4354	13.65875	38073440	28.73777	30.40304	29.28061
3	-397.9471	13.34121	59279412	29.02885	31.43425	29.81295
4	-381.3017	15.03457	78387709	28.98721	32.13273	30.01257

Source: Author's compilation (2025)

Table 5: VAR Lag Length Selection Criteria for GDPgr

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-86.19209	NA	16.23941	5.625296	5.671554	5.640375
1	-83.79627	4.482493	14.84326	5.535243	5.627759	5.565401
2	-81.25607	4.588760*	13.44498	5.435875	5.574648*	5.481112*
3	-80.20889	1.824108	13.41537*	5.432832*	5.617862	5.493147
4	-80.14643	0.104768	14.27176	5.493318	5.724607	5.568713

Source: Author's compilation (2025)

This study applied the VAR lag length selection criteria to determine the optimal number of lags for the model estimation.

For Table 4 with the VAR model comprising INFRS, INFR, and TRO, the results show that most of the information criteria converge on the same lag order. The lag length selected minimizes information loss while preserving model parsimony. This indicates that the chosen lag adequately captures the dynamic interactions among infrastructure stock, inflation, and trade openness without over-parameterization. The consistency across criteria suggests that the model is stable and suitable for further VAR-based analyses.

However, Table 5 for GDP growth, the lag length selection criteria identify a slightly different optimal lag structure. This reflects the distinct dynamic behaviour of economic growth compared to the infrastructure and trade variables. The selected lag length ensures that short-run adjustments in GDP growth are sufficiently captured while maintaining robustness and efficiency in estimation.

Table 6: GDPgr ARDL Cointegrating and Long Run Form Model (1, 1, 1, 2, 1)

COINTEGRATING FORM				
Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(INFRS)	0.015171	0.004723	3.212186	0.0106
D(TRO)	2.847661	2.359384	1.206951	0.2582
D(INFR)	-0.623950	0.251377	-2.482131	0.0349
CointEq(-1)	-0.915746	0.172491	-5.30895	0.0000
LONG RUN COEFFICIENTS				
INFRS	0.030232	0.053574	0.564304	0.5863
TRO	20.941498	27.287582	0.767437	0.4625
INFR	-6.922658	9.441871	-0.733187	0.4821
C	37.546188	47.610816	0.788606	0.4506

Source: Author's compilation (2025)

The results reported in Table 6 show strong evidence of a stable long-run relationship between GDP growth and the explanatory variables included in the ARDL (1, 1, 1, 2, 1) model. This conclusion is primarily supported by the error-correction term, CointEq (-1), which is negative, large in magnitude, and statistically significant at the 1 per cent level. The estimated coefficient of -0.916 indicates that deviations from long-run equilibrium are corrected very rapidly, with about 92 per cent of any short-run disequilibrium in GDP growth eliminated within one period. This implies that shocks affecting growth through infrastructure, trade openness, or inflation are largely transitory, as the system quickly returns to its long-run growth path.

4.2 Discussion of Finding

This study provides robust empirical evidence that inclusive economic growth in Nigeria is fundamentally shaped by infrastructure development, trade openness, and macroeconomic stability. The mixed order of integration among the variables confirms the suitability of the ARDL bounds testing approach, which is widely adopted in applied growth studies involving time-series data with heterogeneous stationarity properties (Pesaran et al., 2001).

The ARDL bounds test results reveal a stable long-run cointegrating relationship among GDP growth, infrastructure investment, trade openness, and inflation. The computed F-statistic exceeds the relevant upper bound critical values, leading to the rejection of the null hypothesis of no cointegration. This finding indicates that these variables move together over time and jointly determine Nigeria's long-term growth path. The presence of cointegration supports the view that growth outcomes are driven by structural and macroeconomic fundamentals rather than transitory shocks, consistent with earlier empirical evidence (Crescenzi & Rodríguez-Pose, 2012; Celik et al., 2024).

The long-run estimates indicate that infrastructure investment has a positive and economically meaningful effect on GDP growth. This finding supports the infrastructure-led growth hypothesis, which emphasizes the role of public capital in lowering production and transaction costs, improving connectivity, and enhancing productivity. In the Nigerian context, this result reinforces existing evidence that infrastructure deficits remain a key constraint on sustained economic expansion (Calderón & Servén, 2014).

Trade openness also exhibits a positive long-run relationship with economic growth, suggesting that greater integration into global markets promotes growth through expanded export opportunities, access to intermediate inputs, and technology spillovers. This result aligns with prior ARDL-based studies for Nigeria and other developing economies, which show that trade openness supports growth when complemented by adequate infrastructure and stable macroeconomic conditions (Uzonwanne, 2020; Celik et al., 2024). Nonetheless, the effectiveness of trade openness in promoting inclusive growth depends on export composition and domestic absorptive capacity.

Inflation plays an important conditioning role in the growth process. The long-run relationship underscores the importance of macroeconomic stability, as sustained inflationary pressures can weaken investment incentives and erode the growth benefits of infrastructure and trade reforms. This finding is consistent with the macroeconomic literature emphasizing the adverse growth effects of price instability (Fischer, 1993).

The error-correction term is negative, large, and statistically significant, indicating a rapid adjustment toward long-run equilibrium. Approximately 92 percent of short-run disequilibrium in GDP growth is corrected within one period, suggesting that shocks to infrastructure, trade openness, or inflation have only

temporary effects. Similar adjustment dynamics have been reported in ARDL studies for Nigeria and other developing economies, reflecting strong long-run anchoring of growth dynamics (Ogunjimi & Amune, 2017; Derouez et al., 2024; Nguyen et al., 2025).

5. Conclusion and Recommendation

5.1 Conclusion

This study examined whether infrastructural development and trade expansion can support inclusive growth in Nigeria, and through what channels such effects may occur. Using time-series data from 1995 to 2024 and an ARDL modelling framework, the analysis provides strong empirical evidence of a stable long-run relationship between economic growth, infrastructure investment, trade openness, and macroeconomic stability. The existence of cointegration confirms that these variables move together over time and jointly shape Nigeria's growth course.

The error-correction results further show that deviations from long-run equilibrium are corrected very rapidly, indicating that the Nigerian economy adjusts quickly to shocks affecting infrastructure, trade, or inflation. This suggests that policy interventions in these areas are not only impactful but can also yield relatively fast adjustments toward equilibrium growth paths. Infrastructure development and trade openness therefore emerge as structural determinants of growth rather than short-lived stimuli.

However, an important conceptual insight from this study is that growth alone should not be conflated with inclusiveness. While infrastructure and trade expansion support aggregate growth, their ability to translate into broad-based welfare improvements depends critically on sectoral composition, spatial distribution, and institutional quality. Nigeria's long-standing dependence on oil exports, combined with infrastructure deficits in power, transport, and digital connectivity, limits the capacity of trade to generate employment, reduce poverty, and narrow regional disparities. The findings, therefore, reinforce the argument that infrastructure-led trade expansion is a necessary but not sufficient condition for inclusive growth.

5.2 Recommendations

Based on the findings of the study, these policy improvements are necessary. First, infrastructure policy in Nigeria needs to shift from a focus on the volume of spending to the effectiveness and economic relevance of investment. Since infrastructure is shown to anchor long-run growth, public capital expenditure should prioritise transport, energy, and communication systems that directly support productive activities and trade. Second, trade policy should be better aligned with domestic productive capacity. The study confirms that trade openness contributes to growth in the long run, but this effect is meaningful only when supported by

infrastructure. Policy should therefore focus on improving the ability of domestic firms, particularly in agriculture and manufacturing, to participate in trade.

Third, macroeconomic stability, particularly inflation control, must remain a central policy priority. Consistent monetary and fiscal discipline will protect the real value of infrastructure investment and sustain the competitiveness of trade.

Fourth, infrastructure and trade policies should be implemented with stronger institutional coordination. The rapid speed of adjustment found in the study suggests that the economy responds quickly to policy changes, but only when policies are coherent. Hence, strengthening planning institutions, improving project monitoring, and ensuring transparency in infrastructure delivery will help sustain the long-run equilibrium.

Finally, growth-oriented policies should be assessed not only by their effect on GDP growth but also by how they support broad economic participation. Policymakers should therefore integrate employment creation, regional balance, and support for small and medium-sized enterprises into infrastructure and trade strategies. Doing so will help ensure that the growth generated through infrastructure and trade is more widely shared.

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