

Globalization, Renewable Energy, and Sustainable Economic Development in Nigeria

Lawrence Udofia¹, Ubong Effiong^{1*}, Charles Okon¹

¹Department of Economics, University of Uyo, P.M.B. 1017 Uyo, Akwa Ibom State, Nigeria

* Corresponding Author

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Abstract

The Sustainable Development Goal 7 (SDG 7) "Ensure access to affordable, reliable, sustainable and modern energy for all" presents the framework within which Nigeria must transit to clean energy use, reduce carbon emissions, and ensure safe environments. This can adequately be achieved through technological transfers which is an outcome of globalization. The aim of this paper was therefore to examine how globalization and renewable energy affects sustainable development in Nigeria. The paper utilized data from 2000 to 2005 which was analysed using the Robust Least Squares (RLS) technique and Impulse Response Functions (IRFs). Findings from the RLS shows that globalization, renewable energy use, capital stock, and access to electricity positively affected sustainable development in Nigeria significantly. However, due to low public investment in renewable energy, our findings showcased that sustainable development is negatively affected by public investment in renewable energy significantly. The policy recommendations emanating from the study include strengthening institutional frameworks for globalization, scaling up renewable energy deployment, improving public investment efficiency, investing in human capital and labour market policies, and prioritizing energy access expansion.

1. Introduction

Sustainable development has become the dominant paradigm for reconciling economic growth with environmental protection and social equity. For Nigeria, this agenda is particularly urgent. With a population exceeding 220 million and an economy historically dependent on crude oil, Nigeria faces the dual challenge of expanding energy access while reducing carbon intensity. Over 80 million people lack access to electricity, and more than 60% rely on traditional biomass for cooking, generating health risks and environmental degradation. The 2030 Agenda for Sustainable Development, particularly Sustainable Development Goals (SDGs) 7, 9, and 12, provides the normative framework within which Nigeria's transition must be assessed.

Globalization constitutes a central external force shaping this transition. As the process of deepening economic, technological, and institutional linkages across borders, globalization influences Nigeria through foreign direct investment, trade openness, technology transfer, and policy diffusion. Theoretical perspectives on globalization and development diverge. The liberal perspective argues that openness accelerates technology diffusion and capital inflows, while the structuralist perspective warns that integration without strong institutions can reinforce dependence and environmental externalities. In Nigeria, empirical evidence supports this duality (see Yusuf & Saheed, 2022). The environmental dimension of globalization in Nigeria is equally nuanced, with studies observing that globalization, alongside real income, urbanization, and energy consumption, positively impacts environmental degradation (see Adebayo et al., 2021). This perspective aligns with the pollution haven hypothesis, which posits that weaker environmental regulations in developing economies attract polluting industries. However, other studies contend that globalization can also facilitate decarbonization by enabling the importation of clean technologies and fostering green investment. The net outcome, therefore, depends on the quality of institutions and the design of trade and investment policies.

Renewable energy is positioned as the cornerstone of Nigeria's response to this challenge. The country is endowed with significant renewable resources, including solar irradiance averaging 5.5 kWh/m²/day, hydropower potential exceeding 11 GW, and substantial biomass reserves (Nkalo, 2025). Policy recognition of this potential is evident in the National Renewable Energy and Energy Efficiency Policy and the 2022 Energy Transition Plan, which target net-zero emissions by 2060 and 30 GW of renewable capacity by 2030. These commitments reflect Nigeria's attempt to align national energy planning with SDG 7 and the Paris Agreement obligations.

Yet, the empirical record reveals a gap between policy ambition and developmental outcomes. Odugbemi (2025) observed that solar energy consumption exerts a negative and statistically significant effect on human development, while biomass consumption is positive but insignificant; with hydroelectric production emerging as the only renewable source with a positive and significant effect. The negative effect of solar is as a result of high upfront costs, weak policy frameworks, and poor integration into productive sectors. This finding underscores a theoretical point: technological adoption does not automatically translate into welfare gains without complementary institutional and financial arrangements.

Globalization can mitigate these constraints if properly harnessed. The theoretical link between globalization and renewable energy deployment operates through three channels: capital, technology, and policy learning. Foreign direct investment and concessional finance can lower the cost of capital for renewable projects. Trade openness facilitates access to solar modules, batteries, and wind turbines, while participation in global policy networks accelerates regulatory learning. In the context of oil-producing African economies, Olanipekun et al. (2022) argue that revenues from oil and gas should be strategically redirected to green energy investment funds, with strong institutional safeguards to prevent rent-seeking. This aligns with the “green industrialization” agenda advanced by SEforALL, which identifies Africa’s opportunity to convert resource endowments into local manufacturing hubs for clean technologies (Sustainable Energy for All [SEforALL], 2024).

However, the effectiveness of globalization in advancing renewable energy and sustainable development is contingent on absorptive capacity. For Nigeria, absorptive capacity is constrained by weak transmission infrastructure, limited technical skills, and fragmented policy coordination. The World Economic Forum’s Energy Transition Index 2023 ranks Nigeria 108 out of 120 countries; while improvements have been recorded in 2025 as the country is being ranked 61 out of 118 countries (World Economic Forum, 2025), noting improvements in political commitment but persistent deficits in system performance and infrastructure readiness. Without addressing these foundational gaps, exposure to global markets may exacerbate energy inequality rather than reduce it.

The social justice dimension further complicates the relationship. A recent Cambridge Prisms study on Nigeria’s renewable energy transition documents both benefits and unresolved harms, including community exclusion, e-waste accumulation, and livelihood disruption in project areas (Amaefule et al., 2026). The study argues that a substantively just transition requires upstream participation, accountability mechanisms, and local content policies that prioritize procurement and skills transfer to host communities. This reflects the theoretical shift from a narrow technocratic view of energy transition to one that centres distributional and procedural justice.

In synthesizing these strands, it becomes evident that globalization, renewable energy, and sustainable development in Nigeria are interdependent but non-automatic processes. Globalization provides the channels for finance and technology, renewable energy provides the pathway for decarbonization and energy access, and sustainable development provides the normative and empirical benchmark for evaluating outcomes. The empirical literature suggests that positive outcomes materialize only when these processes are mediated by strong institutions, coherent policy frameworks, and inclusive governance mechanisms.

Consequently, Nigeria’s sustainable development trajectory will depend on its ability to convert global opportunities into domestic capabilities. This requires policy coherence across the ministries of trade, power, environment, and education; investment in human capital and infrastructure; and the establishment of transparent accountability mechanisms for public and private energy investments. Only through such an integrated approach can Nigeria avoid the middle-income trap and position itself as a regional leader in the global energy transition. Thus, this paper gears towards examining the effect of globalization and renewable energy on sustainable development in Nigeria using time series data from 2000 to 2024.

2 Literature Review

2.1 Conceptual Clarification

Globalization, renewable energy, and sustainable development are intricately linked concepts that influence one another in complex ways. Globalization refers to the increasing interconnectedness of the world’s economies, societies, and cultures through trade, investment, technology, and information exchange (Giddens, 1990). This phenomenon has driven economic growth, technological innovation, and cultural exchange, but it has also raised concerns about inequality, environmental degradation, and cultural homogenization (Stiglitz, 2002).

Renewable energy, on the other hand, refers to energy derived from natural processes that are replenished at a rate equal to or greater than their consumption, such as solar, wind, hydro, and biomass (International Energy Agency [IEA], 2020). Renewable energy is critical for reducing greenhouse gas emissions, enhancing energy security, and promoting sustainable development (Intergovernmental Panel on Climate Change [IPCC], 2018). It offers numerous benefits, including climate mitigation, improved energy access, and economic opportunities through job creation and innovation.

Sustainable development is about meeting the needs of the present without compromising the ability of future generations to meet their own needs (World Commission on Environment and Development [WCED], 1987). It integrates economic growth, social inclusion, and environmental protection, aiming to promote long-term prosperity while protecting the planet. The concept of sustainable development emphasizes the importance of balancing economic, social, and environmental dimensions to achieve a more equitable and resilient future.

The connections between these concepts are multifaceted. Globalization can influence sustainable development by facilitating technology transfer, promoting economic growth, and encouraging global cooperation on sustainability issues. However, it can also lead to environmental degradation, inequality, and exploitation of natural resources if not managed sustainably (Stiglitz, 2002). Renewable energy plays a crucial role in sustainable development by reducing emissions, improving energy access, and stimulating green industries and jobs.

The interplay between globalization and renewable energy can drive sustainable development by accelerating the adoption of clean technologies, promoting international collaboration, and reducing costs. However, this requires effective governance and policies that balance economic growth with environmental and social sustainability. By leveraging globalization and prioritizing renewable energy, countries can promote sustainable development and achieve a more prosperous, equitable, and environmentally resilient future.

The level of globalization, renewable energy use/investments and sustainable development is presented in Table 1.

Table 1: Globalization, renewable energy adoption, and sustainable development in selected West African countries, 2023

Variables/Year	Nigeria	Ghana	Senegal	Burkina Faso	Benin	Togo
Sustainable Development Index (SDI)	0.584	0.646	0.554	0.478	0.542	0.584
Globalization index (KOFGI)	54.336	58.309	61.658	50.714	48.695	49.085
Renewable energy share in the total final energy consumption (%)	51.370	39.360	29.120	70.470	53.660	72.990
Public investments in renewable energy (% of GDP)	0.083	0.077	0.250	0.262	0.305	0.239

Source: Global Green Growth Institute; UNDP; KOF Swiss Economic Institute.

The data in Table 1 shows that SDI in Nigeria stood at 0.584 which is below the 0.646 recorded in Ghana and lies within the same level with Togo with 0.584 as well. Meanwhile, Senegal and Benin recorded 0.554 and 0.542 respectively while Burkina fall below average at 0.478. With respect to globalization, Senegal recorded the highest globalization index of 61.66% followed by Ghana with 58.31% and Nigeria with 54.34% in 2023. Both Togo and Benin recorded lower level of globalization of 49.09% and 48.70% respectively. The share of renewable energy to total energy consumption tends to be the highest in Togo with 72.99% and in Burkina Faso with 70.47%. This was followed by Nigeria with 51.37%, with Senegal and Ghana having the lowest level at 29.12% and 39.36% respectively. These lower share of renewable energy to total energy consumption can be linked to lower public investments in renewable energy as could be seen as 0.083% of GDP and 0.077% of GDP for Nigeria and Ghana respectively, while countries like Burkina Faso and Togo with higher share also has 0.239% and 0.262% as public investments in renewable energy (% of GDP). It therefore follows that public intervention in renewable energy transitions would play critical role in fostering green growth and sustainable development in an economy.

2.2 Theoretical Literature

Understanding the relationship between globalization, renewable energy, and sustainable development in Nigeria requires a framework that integrates economic, environmental, and institutional perspectives. No single theory captures the complexity of this nexus. Instead, a combination of growth theories, political economy perspectives, and transition frameworks provides the explanatory power needed to interpret empirical results and guide policy.

World Systems and Dependency Theory

World Systems Theory, developed by Immanuel Wallerstein (1974), views the global economy as a capitalist world-system with a hierarchical structure of core, semi-periphery, and periphery countries. Dependency Theory, associated with scholars like Andre Gunder Frank (1966), argues that peripheral countries like Nigeria are kept in a state of dependency by core countries, limiting their development. This framework suggests Nigeria's integration into the global economy may perpetuate inequality and hinder sustainable development. Globalization, in this context, may reinforce Nigeria's peripheral position, making it challenging to achieve sustainable development goals. As Wallerstein (1974) notes, the world-system is characterized by a division of labour and unequal exchange, which can lead to the exploitation of peripheral countries. Similarly, Frank (1966) argues that the development of underdevelopment is a result of the incorporation of peripheral countries into the global capitalist system.

Endogenous Growth Theory

Endogenous Growth Theory, proposed by economists like Paul Romer (1986) and Robert Lucas (1988), emphasizes internal factors like human capital, innovation, and knowledge as drivers of economic growth. According to Romer (1986), economic growth is driven by the accumulation of knowledge and technological progress, which can be influenced by government policies and institutions. Lucas (1988) also highlights the importance of human capital in driving economic growth, suggesting that investments in education and training can lead to increased productivity and growth. In the context of Nigeria, this theory suggests that investments in education, R&D, and institutions that foster innovation can drive sustainable development, including the transition to renewable energy. For example, developing local renewable energy technologies could enhance Nigeria's energy security and reduce dependence on fossil fuels.

Energy Transition Theory / Multi-Level Perspective (MLP)

The Multi-Level Perspective, developed by Frank Geels (2002), views energy transitions as socio-technical processes involving interactions between niche innovations, regimes, and landscapes. Geels (2002) argues that transitions involve the co-evolution of technologies, institutions, and user practices, and that these processes are shaped by the interactions between different levels. In the context of Nigeria, this framework can help analyze the country's shift to renewables, considering the role of technological innovation, institutional change, and societal dynamics. For instance, adopting renewable energy could reduce Nigeria's reliance on oil exports and enhance energy access in rural areas.

Sustainable Energy Transition and Just Transition Framework

The Just Transition framework emphasizes equitable and inclusive transitions to sustainable energy, ensuring benefits and costs are fairly distributed (Newell & Mulvaney, 2013). As Newell and Mulvaney (2013) note, a just transition requires that the needs of workers and communities are addressed, and that the benefits of transition are shared equitably. In Nigeria, this means ensuring that renewable energy adoption benefits communities and addresses energy poverty, rather than exacerbating existing inequalities. Globalization could play a role in facilitating technology transfer and investment in renewable energy, but it is crucial to ensure local communities' benefit.

Ecological Modernization Theory (EMT)

Ecological Modernization Theory, developed by Arthur Mol and Gert Spaargaren (1993), argues that economic growth and environmental protection can coexist through technological innovation and institutional change. According to Mol and Spaargaren (1993), modern societies can reconcile economic growth with environmental protection by adopting cleaner technologies and more efficient production processes. In the context of Nigeria, EMT suggests that the country's development path can integrate environmental and economic goals, and that technological innovation can play a key role in achieving sustainable development through renewable energy adoption.

Resource Curse and Rentier State Theory

The Resource Curse, highlighted by Auty (1993) and Ross (2012), argues that resource wealth often leads to poor governance and hindered development. As Auty (1993) notes, resource-rich countries often experience corruption, mismanagement, and conflict, which can undermine economic growth and sustainable development. Ross (2012) also highlights the role of rent-seeking behavior in perpetuating the resource curse, arguing that governments in resource-rich countries often prioritize short-term gains over long-term development. In Nigeria, transitioning to renewable energy could help mitigate the resource curse by reducing dependence on oil revenues and promoting more diversified and sustainable economic growth.

Capability Approach to Sustainable Development

Amartya Sen's (1999) capability approach emphasizes that development should enhance people's freedoms and capabilities. According to Sen (1999), development should focus on expanding people's capabilities and opportunities, rather than just increasing economic growth. In Nigeria, this approach

suggests that policies should prioritize enhancing people's capabilities, including access to renewable energy, education, and healthcare, in order to achieve sustainable development. Globalization can play a role in expanding access to technologies and knowledge, but local contexts and needs should guide development strategies.

Taken together, these theories suggest that globalization and renewable energy influence sustainable development through multiple, interacting channels. Globalization affects development via growth, technology transfer, and environmental spillovers, with the direction of the effect contingent on institutional quality and policy design. Renewable energy contributes to sustainable development by expanding energy access and reducing emissions, but its impact is mediated by the pace of socio-technical transition, the presence of a just transition process, and the degree to which the political economy resists change.

For Nigeria, this integrated framework implies that positive outcomes will not emerge automatically from openness or renewable energy deployment alone. They require institutional reforms that reduce rent-seeking, improve policy coherence, and ensure that the benefits of transition are widely shared. The theoretical framework thus provides the basis for hypothesizing that globalization and capital stock enhance sustainable development, while the impact of renewable energy and public investment depends on the strength of institutions and the management of the transition process.

2.3 Empirical Literature and Research Gap

The empirical literature is filled with studies examining the nexus between globalization and economic growth (Adedoyin et al., 2016; Lawal & Ezeuchenne, 2017; Atan & Effiong, 2020; Dreher et al., 2021; Egwaikhide et al., 2020; Bello & Eze, 2022; Omoju & Adesanya, 2021; Eghon & Ezeoha, 2023; Effiong, 2023). Meanwhile, few studies attempt to establish the nexus between globalization, renewable energy, and sustainable development. Heshmati & Lee (2010) created a new globalization index based on economic growth in order to examine the connection between globalization and income inequality. A panel of data from 61 industrialized and developing nations that were monitored between 1995 and 2001 served as the basis for the empirical analysis. The impact of globalization on income disparity was estimated using panel regression analysis. The findings indicate that globalization and economic growth are positively correlated, whereas inequality and globalization are negatively correlated.

Cervantes et al. (2020) looked at how globalization affected some economic development metrics in 217 nations between 2000 and 2016, particularly per capita income and public health spending. The Toda-Yamamoto procedure, a novel econometric methodology, was employed in the empirical approach to examine potential causal links between the variables in question. The findings indicate that, with the exception of high-income nations, there is a causal link in the Granger sense between globalization and public health spending. This confirms the dual nature of globalization, as suggested by Stiglitz, and may be read both favourably and adversely.

Idoko (2020) examined the relationship between Nigeria's economic development and globalization. The World Bank database (2018) and the Central Bank of Nigeria (CBN) statistics bulletin provided the data. For data analysis, this study included both OLS and co-integration methods. The outcome demonstrates that foreign direct investment (FDI) has a significant role in both globalization and Nigeria's economic development. Nigeria's economic development was inversely correlated with trade and financial openness. The study's overall conclusions show that the Nigerian economy has not yet benefited from the globalization process, despite the co-integration result showing a long-term association between globalization and economic progress.

The empirical study by Effiong (2021) explored the nexus between globalization and economic development in Nigeria from 1970 to 2017. The study utilized several techniques, including Ordinary Least Squares, vector error correction mechanism, impulse response function, and variance decomposition. The result from the data analysis shows that in the short run, economic globalization exerts a negative and significant effect on economic development; while both political and social globalizations exert no significant short run effect. In the long run, economic and social globalization still exerted a deleterious and significant effect on development, while political globalization posed a positive and significant effect on development.

In their analysis of the economic effects of the supply chain for the renewable biofuel and energy sector, English et al. (2022) emphasized the significance of renewable energy in fostering both environmental sustainability and economic development. According to the study's findings, the generation of renewable power is negatively impacted by energy imports, government investment, and urban population expansion, but it is positively and significantly impacted by literacy. This study emphasizes the necessity of policies that lower energy imports and guarantees efficient government expenditure on renewable energy, highlighting the crucial role that macroeconomic factors play in boosting the generation of renewable energy.

Forte and Costa (2024) empirically analyzed the globalization-economic development nexus for 134 developing economies using 2000 to 2019 data. The study utilized the KOF globalization index (disaggregated into economic, political, and social globalization) as a measure of globalization and HDI as a measure of economic development. With the panel data analysis being deployed, the empirical result validated that globalizations and its three core dimensions exerted significant positive effect on HDI. Other key variables observed to have significantly influenced HDI were GDP and infant mortality rate.

Nweke (2026) used time-series data from 1990 to 2022 and the autoregressive distributed lag (ARDL) model to analyze the effects of globalization on Nigeria's economic development. The study's conclusions showed that globalization has a detrimental impact on Nigeria's economic growth through trade openness and exchange rates. However, Nigeria's economic growth was not significantly aided by globalization through inflows of international direct and portfolio investments.

Linus & Odey (2026) looked into how globalization affected Nigeria's economic growth. Annual time series data were used in the study. Per capita gross domestic product was used to gauge economic growth, and the globalization index was used as a proxy for economic globalization. The relationship between globalization and Nigeria's economic growth was established using the ordinary least squares econometric approach. Globalization and economic growth were shown to be positively and significantly correlated in the estimated model.

This study will therefore utilize data from 2000 to 2024 to explore the nexus among globalization, renewable energy, and sustainable development in Nigeria. The study differs from existing studies in the sense that it considers the environmental aspect of development compared to other studies which employ the HDI or per capita income as a measure of economic development.

3 Research Methodology

This study employs the ex-post facto research design to establish the linkages concerning globalization, renewable energy consumption, and sustainable development in Nigeria.

3.1 Model Specification

The empirical model defines sustainable development (SDI) as a function of globalization (KOFGI), renewable energy share in total energy consumption (REUS), public investment in renewable energy (PIRE), and other control variables such as capital stock (GFCF), labour productivity (LABP), and access to electricity (ACET). The model in its stochastic form is given as

$$SDI_t = \beta_0 + \beta_1 KOFGI_t + \beta_2 REUS_t + \beta_3 PIRE_t + \beta_4 GFCF_t + \beta_5 LABP_t + \beta_6 ACET_t + \mu_t \quad (1)$$

Where β_0 is the intercept of the model (assumed to be non-zero and positive), β_1 to β_6 are the partial slope coefficients of the regressors, t is time, and μ is the stochastic term. It is expected that $\beta_1 > 0$, implying that globalization should have a positive effect on sustainable development. This is because globalization enhances technological transfers which can foster clean/renewable energy adoption (pollution halo hypothesis). However, it should be noted that globalization can foster environmental degradation if not properly managed (the pollution haven hypothesis). It is also expected that $\beta_2 > 0$ since renewable energy adoption is a green growth strategy which fosters sustainable development. Increased renewable energy enhances energy access and reduce environmental impacts. Also, it is expected that $\beta_3 > 0$ since increased public investment in renewable energy will foster clean energy adoption, reduce carbon emissions and foster sustainable economic growth. However, this can only occur when there are huge investments and good institutional quality in place. It is also expected that $\beta_4 > 0, \beta_5 > 0, \text{ and } \beta_6 > 0$ since adequate physical capital, productive human capital, and electricity access are core drivers of sustainable development.

The study utilized the Konjunkturforschungsstelle globalization index (KOFGI) as a measure of globalization due to its composite nature and wide use in the literature (see Dreher, 2006; Potrafke, 2015; Effiong, 2021; Effiong, 2023; Forte and Costa, 2024). The study also utilized the sustainable development index (SDI) instead of the conventional human development index (HDI) because it accounts for environmental quality in shaping the human functioning. Thus, the sustainable development index is given by

the sustainable development index is given by

$$SDI = \frac{\text{human development index (HDI)}}{\text{ecological impact index (EII)}}$$

Where:

$$HDI = \sqrt[3]{\text{life expectancy index} + \text{education index} + \text{income index}}$$

$$EII = 1 + \frac{e^{AO} - e^1}{e^4 - e^1}$$

Emanating from the above, average overshoot (AO) is given as

$$AO = \sqrt[2]{\left(\frac{MF}{\text{boundary}} \geq 1\right) * \left(\frac{CO2}{\text{boundary}} \geq 1\right)}$$

Whereby MF is the material footprint, and CO2 is the carbon emissions (see Hicksel, 2020 for detail of the methodology). Data for the study which covers the period 2000 to 2024 were obtained from secondary sources which were Global Green Growth Institute; UNDP; KOF Swiss Economic Institute, and the World Bank. The estimation strategy follows the Robust Least Squares to estimate the parameters of the model and the Impulse Response Functions to ascertain how sustainable development responds to shocks in globalization and renewable energy.

4 Empirical Findings

4.1 Descriptive Statistics

We check for the descriptive properties of the variables in the model to check their behaviour over the years. The finding is presented in Table 2.

Table 2: Variable's descriptive properties

	SDI	KOFGI	REUS	PIRE	GFCF	LABP	ACET
Mean	0.538	51.991	55.501	0.029	23.054	6.266	52.734
Median	0.537	52.803	54.700	0.028	24.625	5.345	53.000
Maximum	0.590	54.628	62.660	0.083	34.049	14.627	62.150
Minimum	0.481	47.489	50.640	0.002	14.163	2.019	43.200
Standard Deviation	0.037	2.208	3.871	0.028	6.999	3.393	5.571
Skewness	-0.152	-0.918	0.278	0.583	0.105	1.014	-0.057
Kurtosis	1.648	2.460	1.592	2.030	1.570	3.032	1.996
Jarque-Bera	1.999	3.810	2.383	2.398	2.175	4.284	1.063
Probability	0.368	0.145	0.304	0.301	0.337	0.117	0.588
Observations	25	25	25	25	25	25	25

Source: Researcher Computation (2026).

It is observed from Table 2 that sustainable development index for Nigeria averaged 0.538 over the study period, with a maximum and minimum values of 0.590 and 0.481 respectively. Also, the index of globalization averaged 51.991% with a maximum and minimum values of 54.628% and 47.489% respectively. The renewable energy as share of total energy consumption averaged 55.501% with a maximum and minimum value of 62.66% and 50.64% respectively, while public investment in renewable energy only averaged 0.029% of GDP over the years. The capital stock, labour productivity, and access to electricity recorded their mean values of 23.054%, 6.266%, and 52.734% respectively. In terms of the shape of the distribution, SDI, KOFGI, and ACET were negatively skewed and platykurtic while the rest of the variables were positively skewed with only LABP being leptokurtic in nature. Overall, the variables were all normally distributed given that the Jarque-Bera statistic of each of the variables were all statistically insignificant pointing the acceptance of the null hypothesis that the data are drawn from a normal distribution.

4.2 Correlation Analysis

We estimate the Pearson correlation coefficients to explore how sustainable development correlates globalization, renewable energy, and the set of

control variables in the model, while also checking for possibility of multicollinearity between the regressors. Table 3 presents the result of the analysis.

Table 3: Correlation matrix

	SDI	KOFGI	REUS	PIRE	GFCF	LABP	ACET
SDI	1						
KOFGI	0.7480	1					
REUS	-0.7732	-0.2916	1				
PIRE	0.8123	0.6152	-0.5198	1			
GFCF	-0.0710	-0.4572	-0.1256	0.1297	1		
LABP	-0.6602	-0.6488	0.5076	-0.4845	0.3473	1	
ACET	0.8974	0.7154	-0.5496	0.5451	-0.0251	-0.6475	1

Source: Researcher Computation (2026).

The correlation matrix in Table 3 shows that while SDI is highly correlated positively with KOFGI ($r = +0.748$), PIRE ($r = +0.8123$), and ACET ($r = +0.8974$), it is however highly correlated negatively with REUS ($r = -0.7732$) and LABP ($r = -0.6602$) but weakly correlated negatively with GFCF ($r = -0.071$). Among the regressors, the correlation matrix depicts that they do not exhibit very high correlations (above 0.80) with each other hence, the possibility of multicollinearity is ruled out in the model.

4.3 Model Estimation

We therefore estimate the model, using the Robust Least Squares technique, to establish the effect of globalization and renewable energy use on sustainable development in Nigeria. Table 4 presents the result where it could be observed that globalization exerts significant positive effect on sustainable development in Nigeria. Also, renewable energy use exerted a significant positive effect in sustainable development in Nigeria while public investment on renewable energy put forth a significant negative effect. Further, capital stock exerted a significant positive effect on while the effect of labour productivity was negative but statistically insignificant. Meanwhile, access to electricity exerted a significant positive effect on sustainable development in Nigeria.

Table 4: Robust Least Squares Estimate

Dependent Variable: SDI				
Method: Robust Least Squares				
Method: M-estimation				
M settings: weight=Bisquare, tuning=4.685, scale=MAD (median centered)				
Huber Type I Standard Errors & Covariance				
Variable	Coefficient	Std. Error	z-Statistic	Probability
KOFGI	0.0081	0.0022	3.6794	0.0002
REUS	0.0049	0.0010	4.7164	0.0000
PIRE	-0.2694	0.1545	-1.7432	0.0813
GFCF	0.0009	0.0004	2.1606	0.0307
LABP	-0.0004	0.0009	-0.4155	0.6778
ACET	0.0022	0.0010	2.2624	0.0237
C	0.2662	0.0895	2.9756	0.0029
Robust Statistics				
R-squared	0.8342	Adjusted R-squared		0.7789
Rw-squared	0.9603	Adjust Rw-squared		0.9603
Akaike info criterion	28.3597	Schwarz criterion		43.2628
Deviance	0.0019	Scale		0.0096
Rn-squared statistic	324.6903	Prob(Rn-squared stat.)		0.0000
Non-robust Statistics				
Mean dependent var	0.5383	S.D. dependent var		0.0374
S.E. of regression	0.0137	Sum squared resid		0.0034

Source: Researcher Computation (2026).

The estimates in Table 4 shows that a 1% increase in globalization leads to about 0.0081% increase in the level of sustainable development in Nigeria. The implication here is that globalization can propel clean technology transfers thereby reducing carbon emissions and fostering green growth strategies. Also, the result shows that a 1% increase in renewable energy use will bring forth about 0.0049% increase in sustainable development. This implies that increased adoption of clean energy sources fosters green growth which is a prerequisite for sustainable development. However, the estimate shows that a 1% increase in public investment in renewable energy yields about 0.2694% decrease in sustainable development. This can be associated with the low investment level since Nigeria has not yet reached the threshold level of 2.89 percent of GDP in investment in renewable energy as stipulated by the World Bank.

The effect of capital stock shows that a 1% increase in the stock of capital is associated with about 0.0009% increase in sustainable development, portraying that adequate capital stock in the areas of energy access and industrial capacity will foster sustainable development. This result therefore connects to the positive and significant effect of energy access where a 1% increase in access to electricity is associated with about 0.0022% increase in sustainable development in Nigeria. The intercept of the model shows that Nigeria will have a sustainable development index of just 0.266 if the regressors are being held constant. The robust statistics indicates an R-squared of 0.8342 and an adjusted R-squared of 0.7789 which indicate that the explanatory variables in the model accounts for about 83.42% of the overall variations in sustainable development in Nigeria, and the explanatory power remains high at 77.89% when the degree of freedom is taken into consideration.

4.4 Impulse Response Functions

The impulse response functions (IRFs) show how sustainable development responds to innovations in globalization and renewable energy use. The responses to shocks are given in Figure 1 through Figure 3.

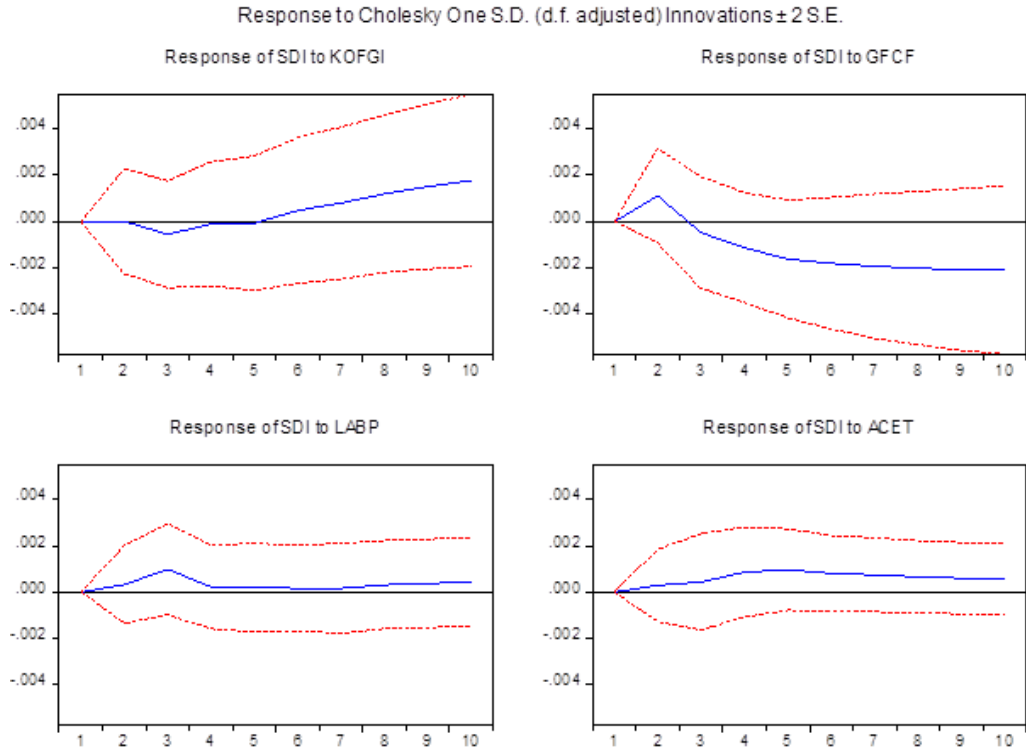


Figure 1: Response of sustainable development to shocks in globalization

Source: Researcher Computation (2026).

In Figure 1, it is observed that sustainable development responded negatively to shocks in globalization in the short run and the effect decomposes in the medium term, after which it became positive in the long run. Also, sustainable development responded positively to shocks in gross fixed capital formation in the short term, but the response became negative in the medium term and long term. Further, sustainable development responded positively to innovations in labour productivity and access to electricity in the short term, medium term, and long term.

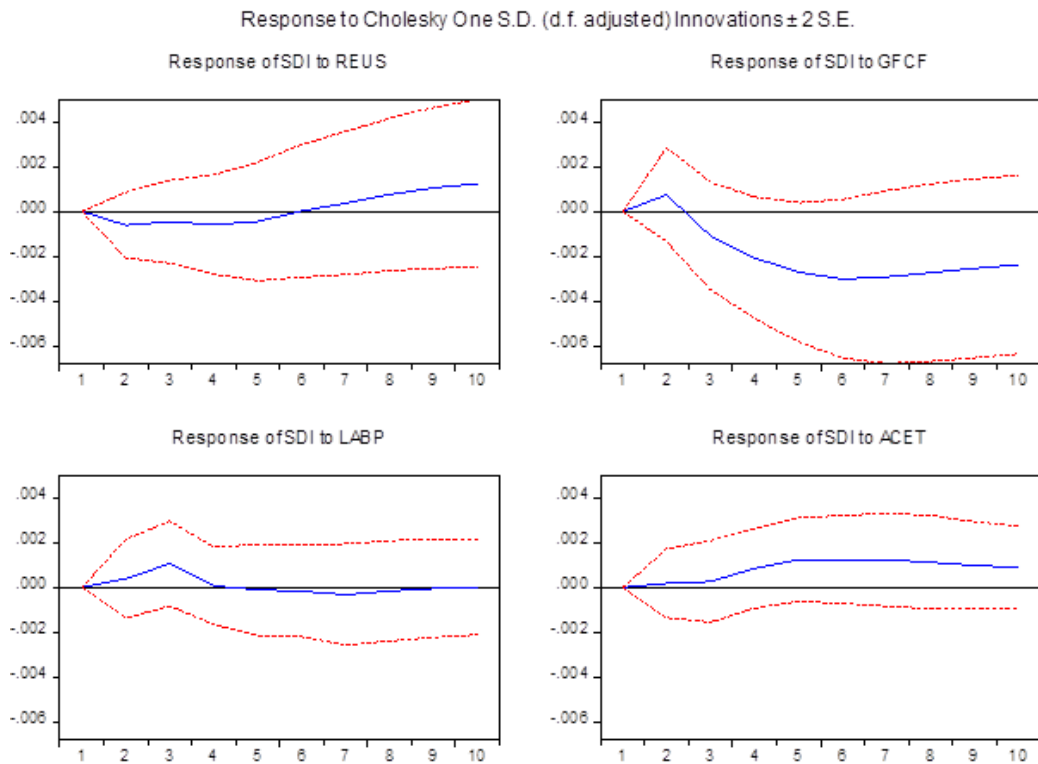


Figure 2: Response of sustainable development to shocks in renewable energy use

Source: Researcher Computation (2026).

The IRFs in Figure 2 presents how sustainable development responds to innovations in renewable energy use and the result shows that in the short term and medium term, SDI responded negatively to shocks in renewable energy use after which the effect became positive in the long term.

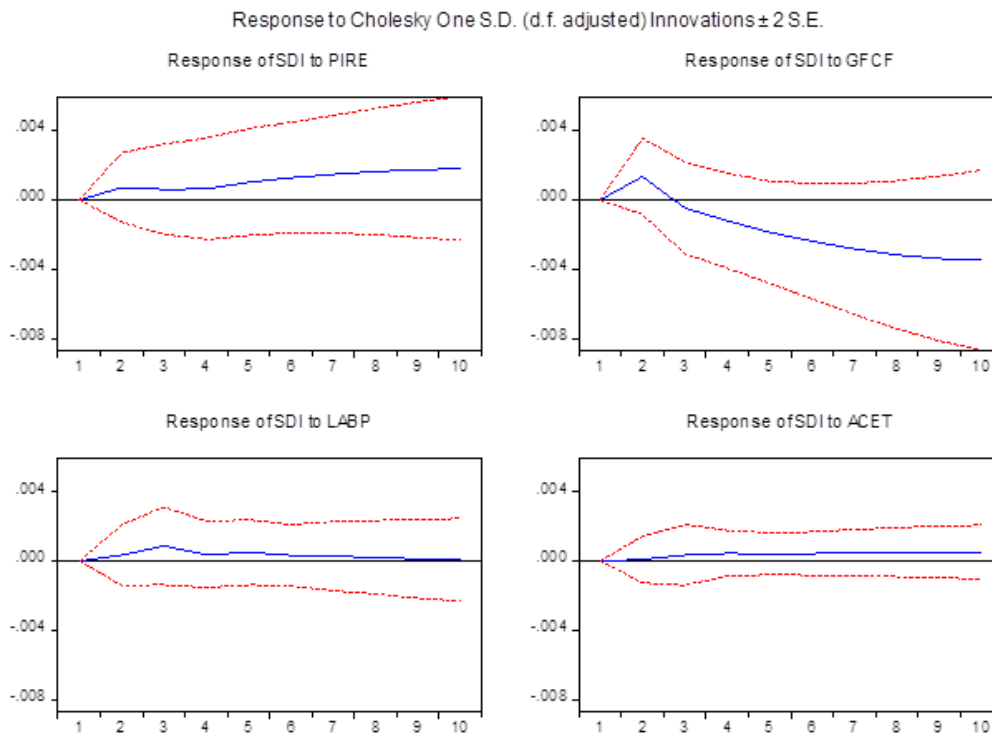


Figure 3: Response of SDI to shocks in public investment on renewable energy

Source: Researcher Computation (2026).

It is further observed from Figure 3 that sustainable development responded positively to shocks in public investment in renewable energy. It therefore follows that positive innovations in renewable energy will translate to improvements in green growth with fosters sustainable development in Nigeria.

4.5 Discussion of Major Findings

The robust least squares estimation yields nuanced insights into the drivers of sustainable development in Nigeria. Each result is interpreted in light of theoretical predictions and empirical literature.

1. Globalization has a positive and significant effect on sustainable development in Nigeria

Globalization is associated with improved sustainable development outcomes, suggesting that increased trade openness, FDI, and knowledge spillovers facilitate cleaner technology adoption and productivity gains. This aligns with the “Pollution Halo Hypothesis”, which argues that globalization brings environmental benefits through technology transfer (Olanipekun et al., 2022). The finding is consistent with Yusuf and Saheed (2022), who report a significant positive effect of globalization on economic growth in Nigeria, though they note the effect is non-increasing, implying structural constraints. The result supports the “Endogenous Growth Theory” view that globalization enhances productivity and innovation capacity (Romer, 1990). Empirically, this is consistent with cross-country studies showing that trade openness and FDI improve sustainable development outcomes when paired with strong institutions (Adebayo et al., 2021). The impulse response functions (IRFs) shows that sustainable development responded negatively to innovations in globalization in the short term, possibly due to initial disruptions and adjustment costs. However, this effect decomposes in the medium term and becomes positive in the long run, suggesting that Nigeria can benefit from globalization with effective management and adaptation.

2. Renewable energy use has a positive and significant effect on sustainable development in Nigeria

Renewable energy deployment is now delivering developmental benefits, likely due to recent policy efforts (e.g., the Energy Transition Plan) and falling technology costs. The result aligns with the “Ecological Modernization Theory”, which argues that cleaner technologies can decouple growth from environmental harm (Mol, 2006). The “Multi-Level Perspective (MLP)” suggests that Nigeria’s renewable transition is moving from the costly niche-expansion phase to regime-level impact. Empirically, this mirrors findings in other developing countries where solar and hydro expansion improve energy access and reduce emissions (International Renewable Energy Agency [IRENA], 2021). The IRFs shows that innovations in renewable energy use have a negative impact on sustainable development in the short and medium term but turn positive in the long term. This could be due to high upfront costs and transition challenges, but the long-term benefits from reduced emissions and energy security are clear.

3. Capital stock has a positive and significant effect on sustainable development in Nigeria

Gross fixed capital formation enhances sustainable development, consistent with “Endogenous Growth Theory” (Romer, 1990). Infrastructure investment expands energy access, industrial capacity, and service delivery, directly contributing to SDG 9 (Industry, Innovation, and Infrastructure). This result matches Okoro and Eke (2019), who find that capital market development significantly drives Nigeria’s economic growth. Global studies also confirm that infrastructure investment is a key enabler of the SDGs (United Nations Conference on Trade and Development [UNCTAD], 2020).

4. Public investment in renewable energy has a negative and significant effect on sustainable development in Nigeria

Public investment in renewables is associated with reduced sustainable development outcomes, reflecting implementation gaps highlighted in the “Resource Curse” and “Institutional Theory” literature. Nigeria’s oil rents reduce incentives for efficient public investment, leading to misallocation, corruption, and delays (Jamiu & Saka, 2026). Bridging the Energy Gap (2025) documents that Nigeria’s renewable projects suffer from weak procurement, land conflicts, and financing bottlenecks. The finding aligns with the “Rentier State Theory”, where resource dependence weakens

governance and policy effectiveness (Mahdavy, 1970). Empirically, this mirrors studies showing that public spending on energy often fails to deliver outcomes in fragile states (World Bank, 2022). From the IRFs, shocks in public investments in renewable energy have a consistently positive impact on sustainable development across all time horizons. This suggests that effective public investment in renewables can drive sustainable development, likely through improved energy access and green growth.

5. Labour productivity has a negative but insignificant effect on sustainable development in Nigeria

Labour productivity gains are not translating into sustainable development, likely due to skills mismatch and informal sector dominance (Nigerian Economic Summit Group [NESG], 2025). The insignificance suggests structural barriers to translating productivity into inclusive growth. This aligns with the “Just Transition Framework”, which argues that transitions create winners and losers. Without policies to manage distributional impacts, productivity gains in formal sectors may be offset by losses elsewhere (Cambridge Prisms, 2025).

6. Access to electricity exerts a significant positive effect on sustainable development in Nigeria

Electricity access is a critical enabler of development, improving health, education, and industrial productivity. The result is consistent with SDG 7 and empirical studies linking energy access to human development (Sustainable Energy for All [SEforALL], 2024). The Capability Approach (Sen, 1999) argues that energy access expands people’s freedoms, aligning with the positive coefficient.

5 Conclusions and Recommendations

Achieving SDG 7 which anchors on ensuring access to affordable, reliable, sustainable, and moder energy for all requires Nigeria to leverage on globalization to foster technological transfers for smooth energy transition. This paper therefore examined how globalization and renewable energy foster sustainable development in Nigeria. Data for the period 2000 to 2005 was utilized for the study, and the analytical technique follows the Robust Least Squares and Impulse Response Functions (IRFs). The empirical result shows that globalization and renewable energy use exerted significant positive effect on sustainable development in Nigeria. On the contrary, public investment on renewable energy was observed to exert a significant positive effect on sustainable development in Nigeria. The result from the IRFs shows that sustainable development in Nigeria responded negatively to innovations in globalization in the short term, the effect decomposes in the medium term and became positive in the long run; sustainable development in Nigeria responded negatively to innovations in renewable energy use in the short term and medium term, but responded positively in the long term; and sustainable development in Nigeria responded positively to innovations in public investments in renewable energy in the short term, medium term, and in the long term.

In terms of applicability, these findings highlight the importance of managing the transition to a more globalized and renewable energy-based economy. Policymakers should prioritize addressing short-term challenges and implementation bottlenecks to unlock long-term benefits. The short-term implications of these findings are that policymakers should be prepared for initial disruptions and costs associated with globalization and renewable energy adoption. In the medium term, the focus should be on managing the transition and addressing implementation challenges. In the long term, Nigeria can reap benefits from globalization and renewable energy, including improved energy security, reduced emissions, and sustainable development. Overall, these findings suggest that a well-managed approach to globalization and renewable energy adoption can drive sustainable development in Nigeria. The findings suggest several policy recommendations to enhance sustainable development in Nigeria:

1. Strengthen Institutional Frameworks for Globalization: This includes

- a) Improve Trade and Investment Policies: Leverage globalization by streamlining trade processes, reducing tariffs on green technologies, and incentivizing FDI in renewable energy.
- b) Enhance Environmental Regulations: Enforce environmental impact assessments for foreign investments and strengthen pollution control mechanisms to prevent the Pollution Haven effect.

2. Scale Up Renewable Energy Deployment: This includes

- a) Increase Investment in Renewables: Expand public-private partnerships for solar, wind, and hydro projects, focusing on decentralized mini-grids for rural areas.
- b) Address Grid Integration Challenges: Upgrade transmission infrastructure and implement smart grid technologies to manage intermittency.

3. Improve Public Investment Efficiency: This includes

- a) Reform Procurement Processes: Enhance transparency, reduce corruption, and ensure value for money in renewable energy projects.
- b) Crowd in Private Capital: Use public funds to de-risk investments and attract green financing from international institutions and private equity.

4. Invest in Human Capital and Labour Market Policies: This includes

- a) Skills Development: Expand vocational training and STEM education to support the renewable energy transition.
- b) Social Protection Programs: Implement just transition policies to support workers displaced by the shift from fossil fuels.

5. Prioritize Energy Access Expansion: This includes

- a) Grid Expansion and Off-Grid Solutions: Accelerate electrification through mini-grids and solar home systems, targeting underserved communities.
- b) Affordability Measures: Subsidize connection costs for low-income households and promote pay-as-you-go systems.

These recommendations aim to leverage Nigeria’s potential for sustainable development by addressing institutional, financial, and social barriers to a green transition.

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Ethical considerations

The article followed all ethical standards appropriate for this kind of research.

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