

Renewable Energy Transition and Sustainable Economic Growth in Nigeria: A Focus on SDG-7

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Suggested citation:

Ukah, P. E. & Eze, O. M. (2026). Renewable energy transition and sustainable economic growth in Nigeria: A focus on SDG-7. *Economic and Business Review*, 2(1), 140-157.

ABSTRACT

This study examines the effect of energy transition, particularly renewable energy consumption, on Nigeria's economic growth from 1990-2023, considering the country's natural resource wealth and commitment to sustainable development goal 7 (SDG-7). The study employed the Autoregressive Distributed Lag (ARDL) bounds testing approach to examine the long-run relationship among renewable energy consumption, natural resource rents, and economic growth. The dynamic ARDL simulation technique was further applied to estimate short- and long-run effects and generate counterfactual scenarios. The findings revealed that renewable energy consumption negatively affects economic growth in both the short-run and long run, indicating challenges in Nigeria's renewable energy integration. However, natural resource rents positively and significantly influence economic growth, suggesting the absence of a resource curse. The interaction between renewable energy consumption and natural resource rents was found to have no significant effect on growth, while capital and labour contributed positively to economic performance. The study recommends a gradual renewable energy transition supported by improved infrastructure, technology, and human capital development. It further emphasizes effective management of natural resources to sustain economic growth in Nigeria.

Keywords: Renewable, Energy, Transition, Sustainable, Economic Growth, SDG-7.

1. Introduction

Energy remains a fundamental driver of economic development, influencing production activities, employment creation, infrastructure development, and overall economic performance. Economic growth depends largely on adequate and reliable energy supply, as it supports industrialization, technological advancement, and improved living standards (Bloom *et al.*, 2022). However, increasing environmental concerns associated with fossil fuel consumption have encouraged global attention toward renewable energy as a sustainable alternative. Renewable energy refers to energy obtained from naturally replenished sources such as solar, wind, hydropower, biomass, and geothermal resources (International Renewable Energy Agency, 2023). Globally, renewable energy adoption has increased due to climate change concerns and the pursuit of sustainable development. This aligns with sustainable development goal 7 (SDG-7), which promotes access to affordable, reliable, sustainable, and modern energy while increasing the share of renewable energy in the global energy mix (United Nations, 2020). It contributes to economic growth through employment creation, technological development, improved energy access, and support for productive activities (Maji *et al.*, 2019; Gershon *et al.*, 2024).

In Nigeria, energy consumption is largely dominated by fossil fuels, particularly petroleum and natural gas, which account for a major share of the country's energy supply (International

Energy Agency, 2021). As one of Africa's leading oil producers, Nigeria depends heavily on crude oil and gas for electricity generation, transportation, industrial activities, and government revenue (U.S. Energy Information Administration, 2022). This dependence is linked to the country's abundant oil and gas reserves, which remain the most accessible energy sources (Oyedepo, 2012). Furthermore, inadequate investments in renewable energy infrastructure, inconsistent policies, and electricity distribution challenges have sustained reliance on fossil fuels (Adewuyi, 2020). Despite Nigeria's significant renewable energy potential, the country continues to experience energy insecurity, frequent electricity shortages, environmental degradation, and vulnerability to global oil price fluctuations. These challenges have negatively affected economic stability and strengthened the need for energy diversification. Renewable energy adoption presents opportunities for improving electricity access, supporting rural development, enhancing agricultural productivity, and reducing dependence on fossil fuels (Olayanju, 2021; Akinmoladun *et al.*, 2020).

However, Nigeria's renewable energy transition faces several obstacles, including inadequate infrastructure, limited investment, weak institutional frameworks, and policy inconsistencies. The high cost of renewable technologies also remains a major constraint in a resource dependent economy (Babatunde & Onuoha, 2019; Osman *et al.*, 2025). Although the government introduced the National Renewable Energy and Energy Efficiency Policy (NREEEP) to promote sustainable energy development (Federal Ministry of Power, 2015), achieving meaningful transformation requires increased investment, technological advancement, and effective policy implementation. Natural resource endowment also plays an important role in economic growth. Resource revenues provide capital for infrastructure development, investment, and human capital formation (Auty, 1993; Hasanov, 2023). Natural resource rents, defined as returns from resource extraction after production costs, can support economic development when effectively managed (World Development Indicators, 2024). However, poor governance, corruption, and commodity price instability may result in the resource curse, limiting sustainable growth (Majumder *et al.*, 2020; Yu, 2023).

Given Nigeria's dependence on fossil fuels and abundance of natural resources, understanding the economic effect of renewable energy transition is essential. Although renewable energy is expected to support sustainable development, its contribution to Nigeria's economic growth remains uncertain, particularly when considered alongside natural resource rents. Therefore, this study examines the impact of renewable energy consumption on Nigeria's economic growth, evaluates the influence of natural resource rents, and investigates the combined effect of renewable energy and natural resource wealth on economic performance.

2. Literature Review

2.1 Theoretical Framework

This study is anchored on the Solow growth model and resource curse theory, which explain the relationship between energy resources, natural resource wealth, and economic growth.

2.1.1 The Solow Growth Model

The Solow-Swan growth model, developed by Solow (1956) and Swan (1956), explains long-run economic growth through capital accumulation, labour growth, and technological progress. The model assumes that output depends on physical capital, labour, and technology, expressed as:

$$Y = AF(K, L)$$

Where, output (Y) is determined by capital (K), labour (L), and technological efficiency (A). The theory suggests that technological advancement and increased investment improve

productivity and promote economic growth. In this study, renewable energy consumption is linked to the productivity factor (A), as improved energy systems can enhance technology, production efficiency, and sustainable economic activities. However, the traditional Solow model does not directly incorporate energy resources and natural resource factors, creating the need to extend the framework to include renewable energy and resource variables. Thus, the model provides a basis for understanding how renewable energy consumption influences Nigeria's economic growth.

2.1.2 Resource Curse Theory

The resource curse theory was introduced by Auty (1993) and advanced by Sachs and Warner (1995) and van der Ploeg (2011). The theory explains why resource-rich countries experience weak economic performance despite abundant natural resources. Although resource wealth can provide revenue for development, poor management create challenges such as Dutch disease, excessive dependence on a single resource sector, rent seeking behaviour, and economic instability. Conversely, effective management of natural resource rents can support economic growth through investment in infrastructure, technology, and human capital. For Nigeria, where oil resources dominate economic activities, the theory is relevant in examining whether natural resource rents contribute positively or negatively to sustainable economic development.

2.1.3 Summary of Theoretical Review

The Solow growth model highlights the importance of capital, labour, and technological progress in promoting economic growth, while renewable energy can enhance productivity through improved energy systems. The Resource curse theory, on the other hand, emphasizes that natural resource abundance can either support or constrain development depending on management practices. Both theories are relevant to this study as they provide a framework for examining the effects of renewable energy consumption and natural resource rents on Nigeria's economic growth.

2.2 Empirical Review

Several empirical studies have examined the relationship between renewable energy consumption, natural resource rents, and economic growth using different econometric techniques, with mixed findings. While some studies established that renewable energy and resource wealth significantly enhance economic growth, others reported insignificant or negative effects due to differences in institutional quality, resource management, and economic conditions. For instance, Shahbaz *et al.* (2020) examined 38 renewable energy consuming economies from 1990 to 2018 using dynamic ordinary least squares (DOLS) and fully modified ordinary least squares (FMOLS). The findings showed that renewable energy, non-renewable energy, capital, and labour positively influenced economic growth. Similarly, Rahman and Velayutham (2020), using Pedroni, Kao, FMOLS, and DOLS methods for five South Asian countries, found that renewable energy, non-renewable energy, and capital formation promoted economic growth. Similarly, Azeakpono and Lloyd (2020) applied OLS and causality analysis to assess renewable energy from 1990 to 2016 and found a significant contribution to economic growth. Maji and Saari (2021) also reported that renewable energy enhanced growth in Nigeria's manufacturing and construction sectors but had insignificant effects on agriculture and transportation.

However, other studies revealed contrasting results, as shown by the work of Ivanovski *et al.* (2021) who found that renewable and non-renewable energy supported growth in non-OECD countries, while only non-renewable energy contributed significantly in OECD countries. Doğan *et al.* (2022) also showed that geothermal energy improved financial development, whereas wind energy negatively affected growth. Similarly, İnal *et al.* (2022) reported that

renewable energy had no significant effect on economic growth in African oil producing countries due to limited utilization. Saba (2023) study further revealed that renewable energy reduced growth in the short run but improved it in the long run. Diallo and Ouoba (2024) emphasized that strong institutional quality enhances the growth effect of renewable energy, while Raihan *et al.* (2025) found that renewable energy and foreign direct investment positively influenced economic growth in Egypt.

Empirical evidence on natural resource rents and economic growth also produced divergent outcomes. For example, Tabash *et al.* (2022), using the system generalized method of moments (GMM) for 24 African countries, found that natural resource rents significantly influenced economic growth. Conversely, Khan *et al.* (2023) reported that natural resource dependence negatively affected economic development in G7 countries using method of moments quantile regression. Furthermore, Hidayat *et al.* (2024), using fixed effects and GMM techniques for ASEAN countries, found that natural resources and renewable energy positively contributed to economic growth. In contrast, Singh *et al.* (2024) revealed that natural resources had a declining effect on GDP in P5+1 countries using quantile-on-quantile regression method.

2.1.1 Gap in Literature

The gap in literature of this study was established based on the location and methodological limitations of previous studies. In terms of location gap, existing studies such as Hidayat *et al.* (2024), Singh *et al.* (2024), and Diallo and Ouoba (2024) mainly focused on panel data analysis involving multiple countries, while studies such as Saba (2023) and Raihan *et al.* (2025) examined individual countries outside Nigeria. These studies provided useful insights into the relationship between renewable energy, natural resources, and economic growth; however, limited attention was given to Nigeria despite its abundant natural resource endowment, dependence on fossil fuels, and emerging renewable energy transition. Therefore, this study contributes to the literature by domesticating the analysis within the Nigerian economy and examining the combined influence of renewable energy consumption and natural resource rents on economic growth.

Furthermore, the methodological gap was identified from previous studies that employed estimation techniques such as OLS, FMOLS, DOLS, fixed effects, and GMM approaches. Although these methods provide valuable evidence on the relationship between energy variables and economic growth, they may not adequately capture dynamic adjustments and possible non-linear relationships among variables. This study contributes to existing literature by applying the dynamic autoregressive distributed lag (DARDL) simulation technique, which provides a more comprehensive assessment of both short-run and long-run effects, while also capturing possible asymmetric responses between renewable energy consumption, natural resource rents, and economic growth in Nigeria.

3.0 Methods

This study examines the effect of renewable energy consumption and natural resource rents on Nigeria's economic growth. It adopts an ex-post facto research design, using existing secondary data that cannot be manipulated by the researcher. The dependent variable is gross domestic product (GDP), while renewable energy consumption, natural resource rents, physical capital, and labour force are the explanatory variables. The study employs the dynamic autoregressive distributed lag (ARDL) simulation technique to estimate both short-run and long-run relationships among the variables. The analysis is conducted using EViews 12 and Stata 16 econometric software packages. The study period is selected based on Nigeria's increasing focus on renewable energy transition, sustainable development, and economic diversification efforts.

3.2 Model Specification

3.2.1 Theoretical framework

Following Solow (1956), Mankiw *et al.* (1992), Hasanov *et al.* (2023), and David *et al.* (2024), this study adopts the augmented Cobb-Douglas production framework to explain the determinants of long-run economic growth. The standard production function is expressed as:

$$Y(t) = A(t) K(t)^\alpha L(t)^\beta \quad 1$$

Where, Y represents output, K denotes capital, L is the labour, and A represents technological progress or total factor productivity (TFP); while the parameters α and β represent the contributions of capital and labour to output growth. However, the traditional Solow model does not adequately capture the role of energy resources in a resource dependent economy such as Nigeria. Therefore, the model is extended by incorporating renewable energy consumption and natural resource rents as determinants of productivity:

$$A(t) = \varphi OR(t)^\gamma TO(t)^\delta \quad 2$$

Where φ is a time-invariant part of A, that is, constant. Substituting equation (2) into equation (1) the augmented Cobb-Douglas production function becomes:

$$Y(t) = \varphi OR(t)^\gamma TO(t)^\delta K(t)^\alpha LB(t)^\beta \quad 3$$

Taking logarithmic transformation and expressing equation (3) in econometric framework yields equation (4) thus:

$$\ln Y_t = \varphi + \gamma \ln OR_t + \delta \ln TO_t + \alpha \ln K_t + \beta \ln LB_t + \varepsilon_t \quad 4$$

Where φ = constant term. The coefficients of oil rent, trade openness, capital and labour are γ, δ, α , and β , respectively. This study adopts GDP as a measure of economic expansion. In order to determine the existence or otherwise of a cointegration among the variables, the general ARDL bounds test after Pesaran *et al.* (2001) is specified as:

$$\begin{aligned} \Delta \ln GDP_t = & \varphi_0 + \varphi_1 \ln PK_{t-1} + \varphi_2 \ln LB_{t-1} + \varphi_3 \ln RE_{t-1} + \varphi_4 \ln NR_{t-1} \\ & + \sum_{i=0}^p \varphi_5 \Delta \ln GDP_{t-1} + \sum_{i=0}^p \varphi_6 \Delta \ln PK_{t-1} + \varepsilon_t \sum_{i=0}^p \varphi_7 \Delta \ln LB_{t-1} \\ & + \sum_{i=0}^p \varphi_8 \Delta \ln RE_{t-1} + \sum_{i=0}^p \varphi_9 \Delta \ln NR_{t-1} \\ & + \varepsilon_t \end{aligned} \quad 5$$

The null hypothesis, $H_0 = \varphi_1 = \varphi_2 = \varphi_3 = \varphi_4 = \varphi_5 = 0$, assumes there is no cointegration among the variables. However, the alternate hypothesis, $H_0 = \varphi_1 \neq \varphi_2 \neq \varphi_3 \neq \varphi_4 \neq \varphi_5 \neq 0$, assumes cointegration among the variables. The error correction model for the estimation of the short-run relationships is specified as:

$$\begin{aligned} \Delta \ln GDP_t = & \varphi_0 \\ & + \sum_{i=0}^p \varphi_1 \Delta \ln GDP_{t-1} + \sum_{i=0}^p \varphi_2 \Delta \ln PK_{t-1} + \varepsilon_t \sum_{i=0}^p \varphi_3 \Delta \ln LB_{t-1} \\ & + \sum_{i=0}^p \varphi_4 \Delta \ln RE_{t-1} + \sum_{i=0}^p \varphi_5 \Delta \ln NR_{t-1} + \lambda_1 ECM_{t-1} \\ & + \varepsilon_t \end{aligned} \quad 6$$

To accommodate for the interaction between renewable energy use and natural resources rent, equation (5) is modified to give equation (7) as follows:

$$\begin{aligned}\Delta \ln GDP_t = & \varphi_0 + \varphi_1 \ln PK_{t-1} \varphi_2 \ln LB_{t-1} + \varphi_3 \ln RE_{t-1} + \varphi_4 \ln NR_{t-1} \\ & + \varphi_5 (\ln RE * \ln NR)_{t-1} \\ & + \sum_{i=1}^p \varphi_6 \Delta \ln GDP_{t-1} + \sum_{i=0}^p \varphi_7 \Delta \ln PK_{t-1} + \sum_{i=0}^p \varphi_8 \Delta \ln LB_{t-1} \\ & + \sum_{i=0}^p \varphi_8 \Delta \ln RE_{t-1} + \sum_{i=0}^p \varphi_9 \Delta \ln NR_{t-1} \\ & + \sum_{i=0}^p \varphi_9 \Delta (\ln RE * \ln NE)_{t-1} + \varepsilon_t\end{aligned}\quad 7$$

The error correction form of equation of equation (7) becomes equation (8).

$$\begin{aligned}\Delta \ln GDP_t = & \varphi_0 \\ & + \sum_{i=1}^p \varphi_6 \Delta \ln GDP_{t-1} + \sum_{i=0}^p \varphi_7 \Delta \ln PK_{t-1} + \sum_{i=0}^p \varphi_8 \Delta \ln LB_{t-1} \\ & + \sum_{i=0}^p \varphi_8 \Delta \ln RE_{t-1} + \sum_{i=0}^p \varphi_9 \Delta \ln NR_{t-1} \\ & + \sum_{i=0}^p \varphi_9 \Delta (\ln RE * \ln NE)_{t-1} + \lambda_1 ECM_{t-1} + \varepsilon_t\end{aligned}\quad 8$$

Jordan and Philips (2018) introduced the dynamic ARDL to simplify interpretation by simultaneously estimating and simulating impacts, generating plots to visualize counterfactual variations in explanatory variables. Error correction form of the dynamic ARDL is specified as:

$$\Delta \ln GDP_t = \alpha_0 + \phi_0 \ln GDP_{t-1} + \delta_1 \Delta \ln PK_t + \phi_1 \ln PK_{t-1} + \delta_2 \Delta \ln LB_t + \phi_2 \ln LB_t + \delta_3 \Delta \ln RE_t + \phi_3 \ln RE_{t-1} + \delta_{14} \Delta \ln NR_t + \phi_4 \ln NR_{t-1} + \gamma_1 ECT_{t-1} \quad 9$$

3.3 Sources of Data

All data were taken from World Development Indicators of World Bank (WDI, 2024), except data for physical capital which was sourced from Pen World Table.

3.4 Estimation Procedure

Preliminary Analysis

Descriptive statistics are computed to highlight the unique characteristics of the data. A unit root test ensures that no variable is an I(2) series, as analysis based on such variables would be misleading. Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests are applied for stationarity. After confirming stationarity, the ARDL bounds test for cointegration is conducted to determine the long-run equilibrium relationship among the variables.

Dynamic ARDL Simulation

Traditional ARDL analysis assumes a constant effect of explanatory variables on the dependent variable, potentially leading to biased results if the true relationship is more complex. Dynamic ARDL estimates the long-run and short-run dynamics of the model and presents counterfactual plots which the standard ARDL does not do.

Diagnosics

Various diagnostic tests are implemented to ascertain the stability and reliability of the models in the system, including Jarque Bera test for normality, Breusch-Godfrey LM test for Serial Correlation, Breusch-Pagan-Godfrey for heteroscedasticity, Ramsey Reset test for specification accuracy. Finally, Cusum and Cusum of squared residuals tests are used for stability of the model.

4. Results

Descriptive Statistics

Table 4.1 indicates descriptive statistics for five variables across 33 observations: lnGDP, lnPK, lnLB, lnREN, and lnNR. lnGDP shows the widest range (25.76–27.03), indicating moderate variation, while lnNR also varies notably (1.52–3.53). In contrast, lnLB has a very narrow range (4.07–4.10), reflecting relative stability in the labour force.

Table 4.1: Descriptive statistics

	LNGDP	LNPK	LNLBF	LNREN	LNNR
Mean	26.40975	14.71898	4.091737	4.432222	2.574502
Median	26.45896	14.71930	4.095427	4.436752	2.717903
Maximum	27.03436	14.87943	4.102395	4.484132	3.534256
Minimum	25.75845	14.54171	4.067949	4.380776	1.516029
Std. Dev.	0.480103	0.102121	0.009422	0.032155	0.496860
Skewness	-0.138935	-0.035511	-1.041894	-0.137940	-0.493417
Kurtosis	1.389242	1.841183	2.942337	1.676392	2.626791
Jarque-Bera	3.673659	1.853363	5.975058	2.513566	1.530549
Probability	0.159322	0.395865	0.050412	0.284568	0.465206
Sum	871.5217	485.7262	135.0273	146.2633	84.95857
Sum Sq. Dev.	7.375956	0.333717	0.002841	0.033086	7.899826
Observations	33	33	33	33	33

Source: Author's computation

The descriptive statistics in Table 4.1 show the central tendency, dispersion, and distribution of the variables used in the study. The mean values indicate that lnGDP (26.41) and lnPK (14.72) are higher than lnLB (4.09), lnREN (4.43), and lnNR (2.57), reflecting differences in scale. The closeness of mean and median values suggests stability and absence of major outliers across the series. For variability, lnGDP and lnNR show the highest standard deviations (0.48 and 0.50), indicating moderate fluctuations, while lnPK is relatively stable (0.10). lnREN (0.03) and lnLB (0.01) exhibit very low variability, showing high stability over time. Skewness results show slight negative skewness across all variables, with lnLB (-1.04) being the most pronounced, indicating a left-tailed distribution. Kurtosis values are below 3 for all variables, suggesting platykurtic distributions (flatter than normal). Furthermore, the Jarque-Bera probabilities are mostly above 0.05, indicating normal distribution for most variables, except lnLB which is marginal at the 5% level. Overall, the results suggest that the data are stable, fairly normally distributed, and suitable for econometric analysis.

Preliminary analysis

Table 4.2: Unit-root tests

Series	Augmented Dickey Fuller		Philip Perron		Remarks
	At Level I(0)	At Difference I(1)	At Level I(0)	At Level I(1)	
lnGDP	-0.509481	-2.719194*	-0.456683	-2.690596*	I(1)
lnPK	-1.412948	-5.359806***	-1.461139	-5.355752***	I(1)
lnLB	-0.149109	-3.880849**	-0.195147	-4.595410**	I(1)
lnREN	-1.336183	-6.324964***	-1.281003	-6.307232***	I(1)
lnNR	-4.193449**	-6.300624***	-3.478603*	-11.94214***	I(0)

Note: *** = $p < 1\%$, ** = $p < 5\%$, * = $p < 10\%$,

Source: Author's computation

The unit root results in Table 4.2 indicate that the variables are a mix of stationary at level and first difference, justifying the use of an ARDL model. For lnGDP, lnPK, lnLB, and lnREN, the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests show that they are non-stationary at level but become stationary after first differencing, as indicated by their significance at I(1). This implies that these variables follow a unit root process and only achieve stability after transformation. In contrast, lnNR is stationary at level under both ADF and PP tests (I(0)), indicating that natural resource rents do not require differencing to achieve stationarity. The presence of a combination of I(0) and I(1) variables confirms that the dataset is suitable for the Autoregressive Distributed Lag (ARDL) approach, which accommodates mixed orders of integration. Importantly, none of the variables is integrated beyond order one, which satisfies the prerequisite for ARDL estimation and ensures that long-run relationships can be reliably examined.

Cointegration test

Once the unit root properties of variables in the model are confirmed, the next stage will be to determine the existence or otherwise of a cointegration.

Table 4.3: Bounds cointegration test

Model	F-statistic	Significance	I(0)	I(1)	Cointegration
Specification 1	11.13979	1%	2.20	3.09	Yes
Specification 2	4.905259	1%	3.06	4.15	Yes

Source: Author's computation

The bounds cointegration results in Table 4.3 confirm the existence of a long-run relationship among the variables in both model specifications. In Specification 1, the computed F-statistic (11.13979) is far above the upper bound critical value at the 1% significance level (3.09). This indicates strong evidence of cointegration, implying that the variables move together in the long run. Similarly, in Specification 2, the F-statistic (4.905259) also exceeds the upper bound critical value at the 1% level (4.15). This further confirms the presence of a stable long-run equilibrium relationship among the variables.

Short and Long run estimates of the dynamic ARDL

The short and long-run estimates of the dynamic ARDL model are presented in Table 4.3, showing results for both the baseline specification (model 1) and the interaction term (model 2).

Table 4.4: Dynamic ARDL Simulation Result

Variable	Model 1				Model 2			
	Coefficient	Std Error	t-statistic	Prob.	Coefficient	Std Error		
t-statistic	Prob.							
Panel A: ARDL short-run estimates								
ECM(-1)	-.2276	.0490	-4.65	0.000	-.1774	.0606	-2.93	0.009
D(lnPK)	.2238	.5487	0.41	0.688	.2598	.5580	0.47	0.647
D(lnLB)	8.8104	1.5776	5.58	0.000	7.50956	1.79563	4.18	0.001
D(lnRE)	-.6195	.2975	-2.08	0.050	1.2611	1.4273	0.88	0.389
D(lnNR)	.0178	.0192	0.93	0.365	3.1535	2.3435	1.35	0.195
RE*NR					-.7077	.5279	-1.34	0.197
Panel B: long run coefficients								
C	-38.5251	6.4846	-5.94	0.000	-	6.51140		0.000
lnPK	1.5903	.3003	5.30	0.000	37.13091	9	-5.70	
lnLB	6.1578	1.1470	5.37	0.000	1.2676	.3865	3.28	0.004
lnRE	-.9543	.2901	-3.29	0.004	4.7231	1.5745	3.00	0.008
lnNR	.0779	.0271	2.87	0.009	.8322	1.4700	0.57	0.578
RE*NR					3.0968	2.3317	1.33	0.201
					-.6819	.5280	-1.29	0.213
No. of								
Obs.	31				31			
Adj-R-sq.	0.6980				0.7017			
Simulation								
ns	5000				5000			
F-stat	7.93				6.88			
P-value	0.0000				0.0002			

Note: *** = $p < 1\%$, ** = $p < 5\%$, * = $p < 10\%$, Source: Author's Construction

Source: Author's computation

The dynamic ARDL simulation results in Table 4.4 show both short-run and long-run relationships with generally good model performance. The ECM(-1) is negative and significant in both models (Model 1: -0.2276; Model 2: -0.1774), confirming long-run equilibrium with a moderate adjustment speed of about 23%. In the short run, labour (lnLB) has a strong positive and significant effect on growth in both models, while capital (lnPK) is positive but insignificant. Renewable energy (lnRE) is negative and significant in Model 1 but becomes positive and insignificant in Model 2. Natural resource rents (lnNR) are positive but insignificant, and the interaction term (RE*NR) is also negative and insignificant, indicating no short-run synergy.

In the long run, capital and labour consistently show positive and significant effects on economic growth across models. Natural resource rents are positive and significant in Model 1 but become insignificant in Model 2. Renewable energy is negative and significant in Model 1 but turns positive and insignificant in Model 2, indicating instability in its long-run impact. The interaction term remains negative and insignificant. Both models are statistically significant ($p < 0.01$) with good explanatory power (Adj. $R^2 = 0.70$), indicating strong model fit. Generally, labour and capital are the most robust drivers of growth, while renewable energy and its interaction with natural resources show weak and inconsistent effects.

Dynamic ARDL graph

The counterfactual graphs of the dynamic ARDL are used to show a change in the regressors affects the regressed (Khan et al., 2020). In this study the predicted changes are show in figures 2 to 6. Figure 2 shows the response of GDP to 10% positive and negative changes in renewable energy consumption.

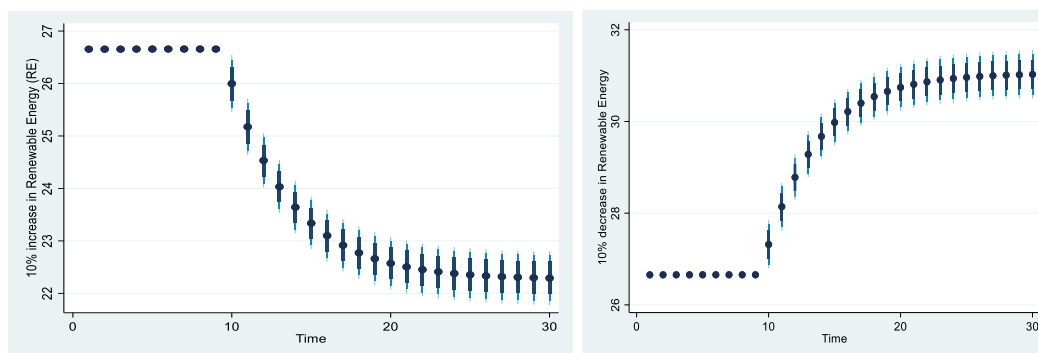


Figure 2: Repose of GDP to Changes in Renewable Energy Consumption (RE)

Note: Dark to light blue indicates 75%, 90% and 95% confidence intervals, respectively

A 10% increase is associated with a decrease in RE both in the short and long run. But a 10% decrease in RE generates positive change in GDP from short to the long-run.

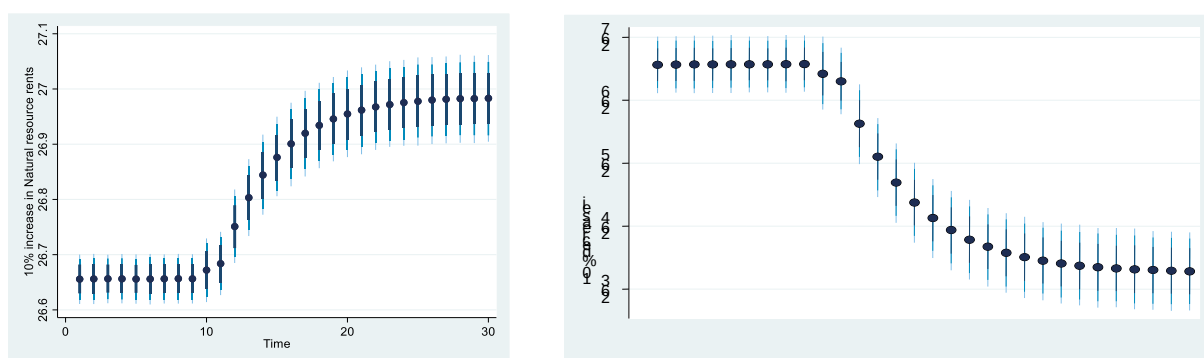


Figure 3: Repose of GDP to Changes in Natural Resources rents (NR)

Note: Dark to light blue indicates 75%, 90% and 95% confidence intervals, respectively

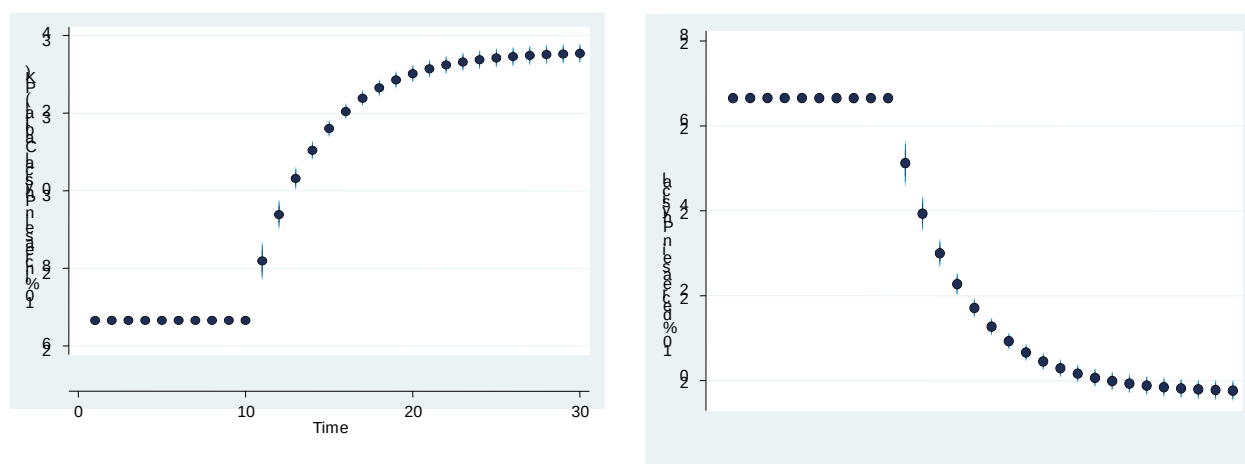


Figure 4: Repose of GDP to Changes in Physical capital (PK)

Note: Dark to light blue indicates 75%, 90% and 95% confidence intervals, respectively

Figure 3 shows that a +10% change in natural resources rents (NR) leads to a positive change in GDP, while a -10% change results in a reduction in GDP, both short and long term. Figure 4 illustrates that a 10% increase in physical capital (PK) significantly boosts GDP from short to long run, while a 10% decrease in PK causes a notable reduction in GDP.

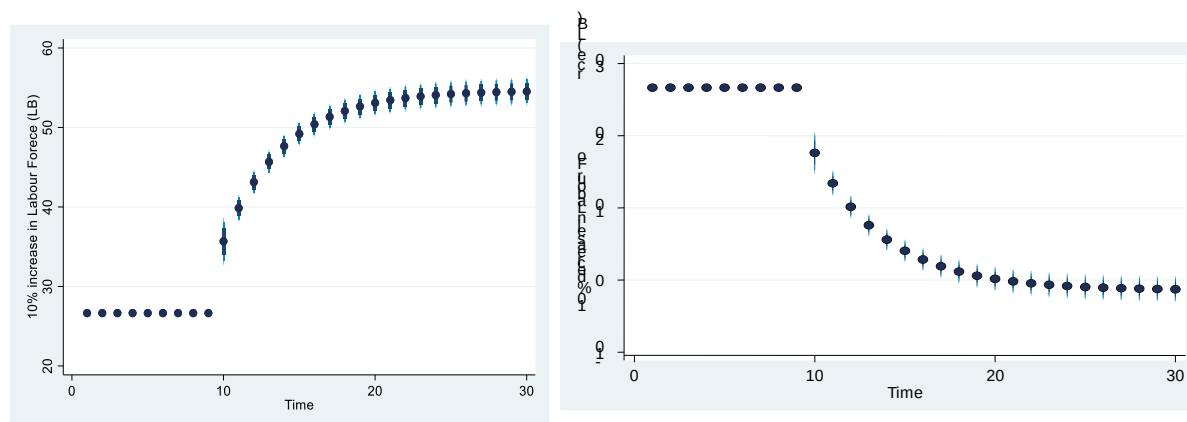


Figure 5: Repose of GDP to Changes in Labour Force (LB)

Note: Dark to light blue indicates 75%, 90% and 95% confidence intervals, respectively

Figure 4 is used to explain how GDP reacts to +10% and -10% negative changes in labour force (LB). The figure shows that +10% change in LB increases GDP, all things being the same. Equally, a -10% change in LB leads to a decrease in GDP.

Diagnostic analysis

Based on the F-statistic values from Table 4.4, the results of the Jacque-Bera test (JB Norm) for normality, the Breusch-Godfrey LM test for serial correlation, the Breusch-Pagan-Godfrey test for heteroscedasticity, and the Ramsey RESET test for specification bias indicate that both models are stable and correctly specified. These findings are further corroborated by the CUSUM and CUSUMQ tests, as shown in Figures 6 and 7.

Table 4.5: Residual Diagnostics tests

Model	JB Norm (F-stat)	BG SLM test (F-stat)	BPG Hetero (F-stat)	Ramsey (F-stat)	Conclusion
Model 1	0.4304	0.0528	0.1038	0.4024	Stable
Model 2	0.3754	0.0802	0.2849	0.3040	Stable

Source: Author's computation

Stability Test

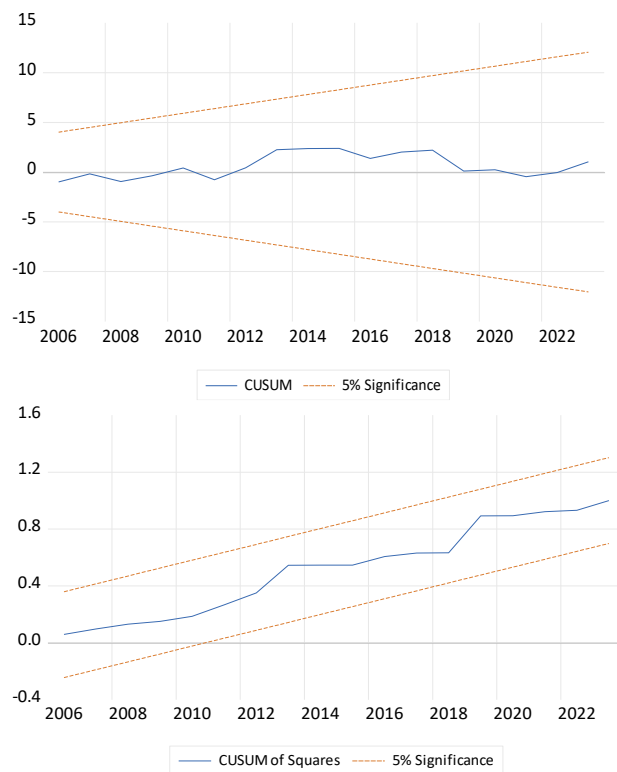


Figure 6: CUSUM and CUSUMSQ residual test (Model 1)

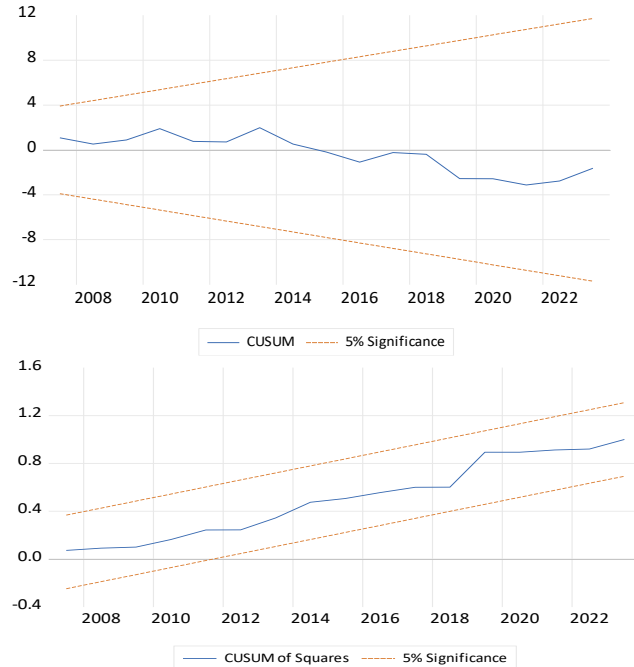


Figure 6: CUSUM and CUSUMSQ residual test (Model 1)

Source: Author's construction

4.1 Discussion of Results

The findings of the dynamic ARDL analysis reveal that renewable energy consumption exerts a negative effect on economic growth in Nigeria. In the short run, the coefficient of renewable energy consumption is negative and weak significant, suggesting that increases in renewable energy use do not immediately stimulate economic growth. This implies that the current level of renewable energy utilization may be insufficient to generate substantial economic benefits in the economy. The result is consistent with the findings of Azeakpono and Lloyd (2020) and İnal *et al.* (2022), who reported limited contributions of renewable energy to economic growth. In the long run, renewable energy consumption continues to exhibit a negative and statistically significant effect on economic growth. Specifically, a one percent increase in renewable energy consumption reduces GDP by approximately 0.95 percent. This finding suggests that the transition towards renewable energy may involve considerable adjustment costs arising from inadequate infrastructure, limited technological capacity, high investment requirements, and weak institutional support. Consequently, renewable energy development may not yet have attained the scale necessary to contribute positively to economic growth in Nigeria. This result supports the findings of Doğan *et al.* (2022) but contrasts with those of Diallo and Ouoba (2024) and Raihan *et al.* (2025), who found positive effects of renewable energy on economic growth in Sub-Saharan Africa and Egypt, respectively.

The results further show that natural resource rents have a positive but insignificant effect on economic growth in the short run, indicating that fluctuations in resource rents do not immediately translate into higher output growth. However, in the long run, natural resource rents exert a positive and statistically significant influence on economic growth. The results indicate that a one percent increase in natural resource rents increases GDP by about 0.08 percent. This finding suggests that Nigeria's natural resource wealth remains an important source of long-term economic growth through increased government revenue, foreign exchange earnings, and investment opportunities. The result aligns with Hidayat *et al.* (2024), who reported a positive contribution of natural resources to economic growth, but contradicts Khan *et al.* (2023), who found that natural resource dependence impeded growth in G7 countries.

Regarding the interaction between renewable energy consumption and natural resource rents, the results reveal a negative and statistically insignificant effect on economic growth in both the short-run and long run. This implies that the combined influence of renewable energy and natural resource rents does not significantly affect economic growth in Nigeria. The insignificant interaction effect may reflect the limited integration of renewable energy development within the broader natural resource sector. Despite the country's abundant resource endowment, renewable energy adoption remains relatively low and constrained by inadequate infrastructure, financing gaps, technological limitations, and policy inconsistencies. Furthermore, Nigeria's continued dependence on fossil fuels may weaken the potential complementarities between renewable energy and natural resource rents. Consequently, the findings suggest that renewable energy consumption and natural resource rents currently operate independently rather than synergistically in driving economic growth in Nigeria.

4.2 Policy implication of the results

The findings of this study provide important policy implications for Nigeria's energy transition and economic development strategies. The negative effect of renewable energy consumption on economic growth suggests that the government should adopt a gradual and strategic approach to renewable energy development. Rather than focusing only on increasing renewable energy usage, policies should prioritize investment in renewable energy

infrastructure, technological advancement, skilled manpower development, and efficient energy distribution systems. Strengthening these areas will reduce transition costs and enable renewable energy to contribute more effectively to economic growth.

The positive long-run contribution of natural resource rents to economic growth highlights the need for improved management and utilization of Nigeria's natural resource revenues. Government should ensure that resource rents are channelled towards productive investments such as infrastructure development, education, technology, and renewable energy projects rather than excessive dependence on consumption. Effective governance and transparency mechanisms are also necessary to maximize the developmental benefits of natural resources and reduce risks associated with resource mismanagement. The insignificant interaction between renewable energy consumption and natural resource rents indicates the need for stronger policy coordination between the energy and natural resource sectors. The government should develop integrated energy policies that link natural resource revenues with renewable energy investments to create complementary effects. For instance, revenue generated from oil and gas resources can be redirected towards financing renewable energy projects, research and development, and clean energy technologies.

Furthermore, the weak contribution of renewable energy to growth implies that Nigeria should address existing barriers such as inadequate funding, inconsistent policies, and limited private sector participation. Creating a stable regulatory environment, providing investment incentives, and encouraging public-private partnerships can enhance renewable energy adoption and improve its long-term economic impact. In all, the results suggest that Nigeria's sustainable growth strategy should combine effective resource management with a carefully planned renewable energy transition.

5. Recommendations

1. Given the negative effect of renewable energy consumption on economic growth, Nigeria should adopt a gradual and strategic energy transition approach. Priority should be given to developing renewable energy infrastructure, improving technology, building technical capacity, and promoting research and development to enhance energy efficiency and reduce transition costs.
2. Since natural resource rents contribute positively to economic growth, Nigeria should strengthen the management of resource revenues by investing in infrastructure, human capital development, and economic diversification. Transparent and accountable resource governance should be promoted to maximize the long-term benefits of natural resources.
3. The insignificant combined effect of renewable energy and natural resource rents suggests the need for better policy coordination. Government should develop sector specific strategies that improve renewable energy efficiency while ensuring effective natural resource management to reduce excessive fossil fuel dependence and support sustainable economic diversification

6 Conclusion

This study examined the impact of renewable energy consumption and natural resource rents on Nigeria's economic growth using annual data from 1990 to 2023, applying the ARDL bounds testing approach and Dynamic ARDL simulation techniques. The findings reveal that renewable energy consumption has a negative effect on economic growth, suggesting that the current level of renewable energy development may not yet provide sufficient economic benefits due to infrastructure limitations, technological gaps, and transition costs. Conversely, natural resource rents have a positive long-run contribution to economic growth, indicating

that Nigeria's resource endowment can support economic development when effectively managed, thereby providing no evidence of the resource curse within the study period.

The study further shows that the interaction between renewable energy consumption and natural resource rents does not significantly influence economic growth, implying that both sectors currently operate independently rather than complementing each other. Additionally, capital and labour were identified as significant drivers of economic growth, highlighting the importance of productive investment and human capital development. Thus, the study concludes that Nigeria requires a gradual and well planned renewable energy transition supported by adequate infrastructure, technological advancement, and skilled manpower. Furthermore, effective governance of natural resource revenues and strategic investment in productive sectors remain essential for achieving sustainable economic growth.

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