Energy Access and Poverty in Nigeria: An Autoregressive Distributed Lag (ARDL) Investigation

Abstract

Determining the effect of energy access on poverty in Nigeria between 1990 and 2023 is very crucial given Nigeria's growing energy demands and rising rates of poverty. In order to achieve the purpose of this study, data on energy access proxies such as volume of electricity generated, electricity consumed, access to electricity as well as on poverty rate were obtained from International Energy Agency and the World Bank. These data were analysed applying Autoregressive Distributed Lag (ARDL) approach after carrying out descriptive statistics and unit root test. The result of the analysis revealed that volume of electricity generated, electricity consumed and access to electricity have negative but significant effect on poverty level in Nigeria while carbon emission has a positive and non-significant effect on poverty index in Nigeria. Based on the findings, it can therefore be inferred that energy access could lead to significant reduction in poverty level in Nigeria. The study recommended among other things that government should promote investment and efficiency in the power sector in order to reverse the rising trend in poverty in Nigeria. This could be achieved by increasing power generation, mass metering of electricity consumption and investing more in renewable energy in order to increase supply, improve access and reduce cost of electricity in Nigeria. This will improve supply and access to electricity thereby making electricity affordable and reduce poverty in the country.

Key words: Poverty rate, electricity generation, electricity consumed and access to electricity

i. Introduction

Energy is vital for all human endeavors and is thus crucial for social and economic development. Energy is an essential element for production, conversion, processing, and commercialization across all enterprises. Energy, particularly electricity, is widely acknowledged as a vital component of a nation's economic advancement and growth. It increases productivity by boosting inputs, namely capital and labor. Thus, improved availability and use of energy work as a dependable indicator of increased economic activity and advancement (Kayode, Akhavan & Ford, 2016). Okeoma, Nwachukwu, Ezeonye, and Osatemple (2023) noted that the lack of electricity access disproportionately affected marginalized populations in most African countries. Frequently, these communities depend on traditional and environmentally harmful energy sources, resulting in increased deforestation, soil degradation, and air pollution.

According to the World Bank (2022) only 60.5% of the total population in Nigeria has access to electricity. This represents a slight improvement from 53% in 2012 and 59.5% in 2020. The proportion of people living in the rural area with access to electricity was just 27% as at 2022. During same period, the World Bank also reported that about 63% or 133 million persons in Nigeria were multidimensionally poor while absolute poverty reached 44.7%. most development experts have attributed the rising poverty level to low level of infrastructure especially electricity and good transport system.

The increase pressure on fossil fuel and forest energy sources due to low energy diversification have contributed to climate change and create a persistent pattern of environmental degradation and socio-economic challenges. The transition to renewable energy sources is essential for mitigating the effects of climate change. Access to renewable and sustainable energy sources, such as solar, wind, and hydropower, provide a potential alternative to conventional fossil fuels. This not only mitigates greenhouse gas emissions but also fosters the development of a sustainable energy future and economic growth. Decentralized renewable energy solutions, such as off-grid solar systems and mini-grids in African countries, provide the opportunity to obtain power while minimizing impact on climate change. Decentralized systems empower communities to generate their own renewable energy, hence reducing dependence on centralized power sources that use fossil fuels. This thus fosters economic advancement and growth, resulting in poverty alleviation.

The enhancement of energy efficiency and the promotion of energy conservation directly contribute to climate change mitigation. Access to technology that enhances energy efficiency lowers overall energy demand, thereby lowering greenhouse gas (GHG) emissions associated with energy production, while simultaneously fostering economic advancement. Zakariya, Effat, and Mohammad (2023) contend that the provision of reliable and sustainable energy services is crucial for developing climate resilience and adaptation. Clean energy technologies can enhance community resilience against adverse events by providing electricity for essential services, supporting emergency response initiatives, and fostering economic activities that are less vulnerable to climate change impacts. Consequently, access to reliable and sustainable energy sources is essential for promoting economic growth and alleviating poverty.

Regrettably, challenges in energy access persist in Nigeria throughout time, hindering socioeconomic advancement and exacerbating existing inequities. A significant challenge in Nigeria is the insufficient electrical supply, particularly in rural areas. Despite focused efforts to improve accessibility, a significant portion of the population, especially in remote and underprivileged areas, nevertheless encounters a lack of reliable and affordable energy access. This hinders economic activities, limits educational opportunities, and affects overall quality of life, resulting in an escalation of poverty levels. Given the characteristics of energy access and the rise in poverty levels in Nigeria throughout the years, it is essential to examine the influence of energy access on poverty levels in Nigeria from 1990 to 2023. We will further our inquiry by analyzing relevant literature on the issues at stake.

ii. Literature Review

Theoretical Review

This research is based on Energy Transition Theory. Energy transition theory comprises the theoretical framework and guiding principles that enable the transformation of energy systems from traditional, fossil fuel-dependent sources to more sustainable, low-carbon, and environmentally benign alternatives. This transition is driven by the recognition of the need to address pressing global challenges, including climate change, energy security, and environmental sustainability. Energy transition theory is an integrative framework that encompasses several disciplines, including economics, technology, politics, and social dynamics. The notion of linking energy consumption to economic growth is mostly attributed to the energy transition theory. Hosier and Dowd (1987) and Leach (1992), proponents of the energy transition theory, demonstrated a correlation between energy use and income levels. Energy is often seen as a fundamental stimulant for the modern economy, especially in countries that have had rapid growth in recent years. The concept suggests that a nation's energy consumption habits are strongly linked to its per capita income level. According to consumer theory, this concept posits that when individuals' income increases, they are more inclined to transition from conventional or inferior energy sources to modern energy sources due to the convenience and comfort these provide. The concept clearly indicates a link between economic status and energy use. Affluent countries tend to use a larger quantity of superior energy relative to less affluent ones. Furthermore, Energy Transition theory posits that a nation's capacity to mitigate poverty and attain sustainable prosperity is impeded by insufficient access to modern energy. Access to energy is essential for poverty alleviation, since energy deficiency impedes productivity and constrains economic activity levels.

The Energy Transition Theory provides a valuable framework for analyzing the correlation between energy availability and poverty levels. The theory, derived from the overarching ideas of energy development and socio-economic advancement, elucidates how transitions from conventional, low-efficiency energy sources to more sophisticated and sustainable energy systems may enhance economic and social welfare. This transition often entails shifting from conventional biomass and fossil fuels to contemporary, cleaner energy sources, such as renewable energy (e.g., solar, wind, and hydropower). Energy poverty, characterized by insufficient access to dependable and inexpensive modern energy, often sustains cycles of economic deprivation, especially in emerging areas. The Energy Transition Theory posits that access to modern energy services empowers communities to facilitate vital economic and social services, enhancing health, education, and productivity, ultimately reducing poverty.

Review of Empirical Literature

Haliru (2023) conducted a case study on renewable energy sources to evaluate the impact of energy consumption on sustainable development in Nigeria from 1980 to 2021. This research, employing the ARDL Model, revealed that green growth exhibits a positive and statistically significant relationship with its initial lag and current value, while a positive and statistically significant correlation exists between energy consumption and sustainable development.

Salisu and Moronkeji (2022) analyzed data from 1980 to 2021 to assess the impact of Nigeria's electricity usage on industrial output. Diagnostic tests conducted included descriptive statistics, correlation, the unit root test, and the ARDL. Research indicates that stringent supervision of the government's power privatization policy is essential to guarantee enough electricity production and consumption, hence promoting extensive job opportunities for both professional and unskilled laborers.

Eseyin and Ogunjobi (2021) examined the effect of sustainable power provision on poverty alleviation in Nigeria. This research analyzed time series data from 1981 to 2018. The study's findings indicated that, in addition to the historical poverty level exerting a direct and statistically significant influence on the current poverty rate, a lower unemployment rate does not effectively correlate with a decrease in poverty levels in Nigeria.

Akintunde, Adagunodo, Akanbi, and Ogunleye (2020) examined the interplay between poverty and energy consumption on life expectancy in Nigeria from 1980 to 2017. The research used secondary data. The Autoregressive Distributed Lag (ARDL) technique was used to analyze the time series data. The research demonstrated that poverty adversely and significantly affects life expectancy both in the short term and the long term. Moreover, energy consumption exerted a favorable and considerable influence on life expectancy in the long term.

Arouna and Richard (2020) examined the impact of household access to electricity on poverty in Côte d'Ivoire and its fluctuations over the last two decades. The research demonstrated a substantial and considerable impact of power availability on per capita home consumption. Access to electricity increases household consumption per capita by 5.2 to 23.3 percent. The findings indicated that a decrease in regional power availability correlates with an increase in regional poverty rates.

Diallo and Moussa (2020) investigated the influence of household access to electricity on poverty in Côte d'Ivoire and its evolution over the previous two decades. Their results demonstrate a substantial and considerable impact of power availability on per capita home consumption. Access to electricity increases household consumption per capita by 5.2 to 23.3 percent. The research demonstrated that a lower regional power access rate correlates with a greater regional poverty rate.

Oshota (2019) analyzed the impact of information and communication technology (ICT), energy availability, and transportation infrastructure on poverty alleviation and inclusive development in Nigeria from 1980 to 2014, using the error correction modeling (ECM) methodology. The findings demonstrated that access to power and transportation infrastructure has a negative and statistically significant impact on both the incidence and depth of poverty reduction, leading to the conclusion that this results in inclusive growth. The research specifically indicated that access to ICT adversely affects poverty incidence; however, this link lacks robustness when poverty is measured by the poverty gap.

Shaobin and Haixia (2019) investigated the correlation between household energy usage and life expectancy at birth in mainland China. A strong correlation was identified between home coal/household power use and life expectancy at birth at the province level in mainland China for the years 1990, 2000, and 2010. Household coal had a substantial negative correlation with life expectancy at birth, but household electricity shown a favorable correlation with life expectancy at birth. It was discovered that household coal had a negative correlation with life expectancy in rural parts of China compared to metropolitan areas. Moreover, spatially weighted regression revealed spatial non-stationarity in the relationship between home energy use and life expectancy at birth in mainland China, particularly for household coal and electricity usage.

Okwanya and Abah (2018) examined the influence of energy consumption on poverty alleviation in a panel of 12 African nations from 1981 to 2014. The research, using the Fully Modified Ordinary Least Squares (FMOLS) approach, demonstrated a long-term negative correlation between energy consumption and poverty levels, highlighting the significance of energy in alleviating poverty in the chosen African nations. The findings also demonstrated that characteristics like as capital stock and political stability significantly influence poverty, suggesting that these elements are crucial in alleviating poverty.

Girma, Girma, and Dereje (2015) investigated the effects of rural electrification on poverty alleviation in Northern Ethiopia. The research aimed to assess the effects of the rural electrification initiative on family income, health, education, and agricultural activities. Primary data were used, and legitimate regression was employed to assess the influence of electricity on poverty. The findings indicated that electricity positively and significantly affects poverty reduction, although the influence of electricity availability on family income is positive however small.

Muawya and Walter (2012) investigated the correlation between energy availability and enhancements in living conditions and poverty alleviation in sub-Saharan Africa. The research indicated that fundamental components of human welfare—such as leading a long and productive life, enjoying good health, accessing knowledge and educational opportunities, and having the capacity to earn adequate income for sufficient nutrition, shelter, and other material and aesthetic needs—can only be enhanced if modern energy is accessible to all. However, nearly 2 billion individuals in developing countries remain without electricity. The research revealed that electricity may significantly benefit distant rural regions, and renewable energy technologies provide a crucial opportunity in places inaccessible by the grid.

Thiam (2011) examined the role of renewable energy in elevating the quality of living in Senegal, a developing Sahelian nation, using a life-cycle cost methodology that included an analysis of environmental externalities. The research revealed that in remote rural villages without power access, photovoltaic (PV) renewable technologies provide a viable solution for energy services, whereas wind technology also serves as a supplement.

Literature Gap

A multitude of academics and intellectuals have conducted pertinent investigations on the topic matter, consistent with the examined literature. Nonetheless, it was noted that no previous study has conducted a thorough examination of how indicators of energy access (electricity generation volume, electricity consumption, electricity accessibility, and carbon emissions) influence poverty in Nigeria. This study aimed to fill this gap by doing an empirical examination of the effect of electricity availability on poverty in Nigeria.

iii. Methodology

Due to the peculiarities of this inquiry, an ex-post facto research design is used. Annual time series data from 1990 to 2023 were used, acquired from the International Energy Agency, International Monetary Fund (IMF) Statistics, and the World Development Indicators of the World Bank. This study's analytical approach is based on the Energy Transition Theory, selected for its relevance and application to the research. The model for this study was based on the empirical research of Diallo and Moussa (2020). This model was modified in accordance with the objectives and specific aims of this study with minimal adjustments. Hence the functional form of the model is stated thus:

$$PI = f(VEG, ELC, AEC, CES) \quad (1)$$

To ease of estimation and to account for other variables that affect poverty outside energy access equation 1 is stated as follows:

$$PI_t = \delta_0 + \delta_1 VEG_t + \delta_2 ELC_t + \delta_3 AEC_t + \delta_4 CES_t + U_t \quad (2)$$

ARDL Model Specifications

$$\Delta(PI_t) = \delta_0 + \delta_{1i}\Delta(PI_{t-1}) + \delta_{2i}\Delta(VEG_{t-1}) + \delta_{3i}\Delta(ELC_{t-1}) + \delta_{4i}\Delta\ln(AEC_{t-1}) + \delta_{5i}\Delta\ln(CES_{t-1}) + \sum_{t=1}^{p}\beta_{1i}\Delta(PI_{t-1}) + \sum_{t=1}^{q}\beta_{2i}\Delta(VEG_{t-1}) + \sum_{t=1}^{p}\beta_{3i}\Delta(ELC_{t-1}) + \sum_{t=1}^{q}\beta_{4i}\Delta(AEC_{t-1}) \sum_{t=1}^{q}\beta_{5i}\Delta(CES_{t-1}) + \varepsilon_{1i} \quad (3)$$

In furtherance, the short run dynamic parameters are arrived at by the estimation of an error correction model linked with the long-run estimates. The models are stated below:

$$\Delta\ln(PI_t) = \beta_0 + \sum_{t=1}^{p}\beta_{1i}\Delta(PI_{t-1}) + \sum_{t=1}^{q}\beta_{2i}\Delta(VEG_{t-1}) + \sum_{t=1}^{p}\beta_{3i}\Delta(ELC_{t-1}) + \sum_{t=1}^{q}\beta_{4i}\Delta(AEC_{t-1}) \sum_{t=1}^{q}\beta_{5i}\Delta(CES_{t-1}) + \delta ECMT_{t-1} + \varepsilon_{14i} \quad (4)$$

Where: PI = Poverty Index, VEG = Volume of electricity generated, ELC =Electricity consumed, AEC = Access to Electricity, CES = Carbon emission, δ_0 = Constant variables in the model, δ_1 - δ_4= Co-efficient of volume of electricity generated, U_i = Error term, Δ = Difference operator and indicates the optimum lag, t = Time lag

A Priori Expectation: $\delta_1 < 0$; $\delta_2 < 0$; $\delta_3 < 0$; $\delta_4 > 0$.

The ARDL limits cointegration test was used to ascertain the presence of cointegration between the proxies of the dependent variable and those of the independent variables (regressors). Pesaran, Shin, and Smith (2001) assert that the limits cointegration test is applicable for assessing cointegration among variables of order I(0) and I(1). Additionally, both long-run and short-run estimates were performed using the Autoregressive Distributed Lag (ARDL) methodology. The Autoregressive Distributed Lag (ARDL) method is a widely used econometric methodology for modeling the relationship between a dependent variable and many independent variables across both short and long-time horizons. The ARDL methodology is especially advantageous in this analysis, since the model's variables exhibit integration at varying orders; specifically, certain variables are stationary at level I(0), while others are stationary at first difference I(1).

iv. Results and Discussion

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v. Table 1: Summary Statistics

	PI	VEG	ELC	AEC	CES
Mean	54.67059	16.09692	115.8841	48.19882	45.83390
Median	54.80000	16.18365	122.2813	48.98500	46.84420
Maximum	66.90000	22.40386	173.0447	65.10000	54.46350
Minimum	39.10000	10.52038	71.92220	30.52000	33.15260
Std. Dev.	6.653435	3.380140	31.19929	8.857669	5.872118
Skewness	-0.347450	0.064667	-0.007407	-0.161551	-0.276220
Kurtosis	3.038036	1.884428	1.683902	2.302196	2.117282
Jarque-Bera	0.686139	1.786741	2.454138	0.837712	1.536206
Probability	0.709589	0.409274	0.293150	0.657799	0.463892
Sum	1858.800	547.2954	3940.059	1638.760	1558.353
Sum Sq. Dev.	1460.851	377.0365	32122.06	2589.124	1137.898
Observations	**34**	**34**	**34**	**34**	**34**

Source: ***Author's Computation, 2024.***

Table 1 above delineates the descriptive statistics of the study variables (poverty index, amount of electricity produced, electricity used, access to electricity, and carbon emissions) throughout a thirty-four-year period from 1990 to 2023. The Poverty Index (PI) had a mean value of 54.67% for the period, with a high of 66.9% and a minimum of 39.1% annually. The standard deviation of the poverty index (PI) volume is 6.65%, indicating a significant dispersion from the mean. The volume of electricity produced (VEG) has a mean of 16.1, a maximum of 22.4, and a low of 10.52 per year. The standard deviation of the volume of electricity produced (VEG) is 3.38, indicating significant dispersion from the mean. Additionally, the electricity consumption (ELC) had a mean value of 115.88, with a maximum of 173.04 and a minimum of 71.92 annually. The standard deviation of electricity consumption (ELC) is 31.2, indicating significant dispersion from the mean. Furthermore, access to electricity (AEC) had a mean value of 48.20, with a maximum of 65.1 and a minimum of 71.92 annually. The standard deviation of access to electricity (AEC) is 8.85, indicating a significant departure from the mean. Finally, carbon emissions (CES) exhibited an average value of 45.83% during the period, with a high of 54.46% and a low of 33.15% per year. The standard deviation of carbon emissions (CES) is 5.87%, indicating a minimal departure from the mean.

Unit Root Test

The examination of unit roots in a series is a prerequisite for establishing a cointegration connection. This research first used the well-recognized Augmented Dickey-Fuller (ADF) unit root test to examine the stationarity of all variables involved. The results of the unit root test are shown in Table 2 below:

Table 2: Augmented Dickey-Fuller (ADF) Test Results

Variables	ADF				I(d)	Stationary @
	Level	Critical Value @ 5%	1st Difference	Critical Value @ 5%		
PI	-2.216106	-2.954021	-6.418812**	-2.957110	I(1)	1st Difference
VEG	-4.265521	-2.957110***	-	-	I(0)	Level
ELC	-0.995851	-2.954021	-6.999825***	-2.957110	I(1)	1st Difference
AEC	-0.713927	-2.957110	--9.377335***	-2.957110	I(1)	1st Difference
CES	-2.633673	-2.954021	-6.697504***	-2.957110	I(1)	1st Difference

Note: *, **, and * denote significance at 10%, 5% and 1%, respectively**

Source: ***Author's Computation, 2024.***

Table 2 displays the summarized results of the ADF unit root tests conducted on all variables inside our model. The unit root test findings indicated that electricity produced (VEG) achieved stability at the level. This is due to the test statistic value of electricity produced (VEG) exceeding the Mackinnon critical value at the 5% significance level. This further suggests that the electricity produced (VEG) was stationary at zero order [i.e., I(0)]. Conversely, the poverty index (PI), energy consumption (ELC), access to electricity (AEC), and carbon emissions (CES) achieved stability during initial differencing. This is due to their test statistic values exceeding the Mackinnon critical value at the 5% significance level in the first difference. This further signifies that the poverty index (PI), energy consumption (ELC), access to electricity (AEC), and carbon emissions (CES) were integrated at first order [i.e., I(1)]. Ultimately, achieving mixed stationarity in the variables (stationary at order zero and stationary at order one) required the use of ARDL for estimating the long-run link among the variables and the error correction model.

Correlation Analysis

For the purpose of this study, correlation matrix is used to detect multicollinearity. The correlation matrix involves examination of correlation coefficients between pairs of dependent and independent variables. The results of the correlation are presented in Table 3:

Table 3: Correlation Matrix

	PI	VEG	ELC	AEC	CES
PI	1				
VEG	0.193106	1			

ELC	-0.53595	0.195942	1		
AEC	-0.43766	0.41299	0.486596	1	
CES	0.164479	0.303277	-0.17461	-0.06554	1

Source: ***Author's Computation, 2024.***

The correlation matrix in Table 3 revealed that the amount of electricity produced, electricity used, access to electricity, and carbon emissions exhibit modest positive and negative correlations with the poverty index (PI). Also, the result shows no evidence of multicollinearity given the correlation coefficient of the explanatory variables. Therefore, there is enough statistical evidence to assert the lack of multicollinearity among the independent variables.

ARDL Bound Cointegration Test

Considering the variables exhibit mixed stationarity, specifically integrated of order zero [I(0)] and integrated of order one [I(1)], we will proceed to determine the existence or absence of a long-run cointegrating relationship among the variables in the equation utilizing the Autoregressive Distributed Lag (ARDL) bounds cointegration test. The outcome of the ARDL cointegration test is shown in Table 4:

Table 4: ARDL Bounds Cointegration Test

	Critical Value Bound		**F-Statistics**
F_{PI}(VEG, ELC, AEC, CES) K = 4			5.833933***
Significance	I(0) Bound	I(1) Bound	
10%	2.2	3.09	
5%	2.56	3.49	
2.5%	2.88	3.87	
1%	3.29	4.37	

Note: Null hypothesis: No level relationship; K = number of regressors; *, ** and *** denote significance at 10%, 5% and 1% level, respectively.

Source: ***Authors' Computation, 2024.***

A limits test was done to ascertain if cointegration exists among the poverty index (PI), volume of electricity produced (VEG), electricity used (ELC), access to electricity (AEC), and carbon emissions (CES). The ARDL Bounds correlation test results in Table 4 indicate a long-run relationship among the poverty index (PI), volume of electricity generated (VEG), electricity consumed (ELC), access to electricity (AEC), and carbon emissions (CES), as evidenced by an F-statistic value of 5.833933, which exceeds the 5% upper bound critical value of 3.49. The null hypothesis is rejected, resulting in the conclusion that a cointegrating connection exists among the variables. The validation of long-term dynamics among the variables further required the assessment of the link between the dependent and independent variables via the estimate of the Autoregressive Distributed Lag (ARDL) model.

Autoregressive Distributive Lag (ARDL) Long-Run and Short-Run Dynamics

The long-run and the short-run econometric model is estimated in this section and the results obtained are presented in Table 5:

Table 5: Estimated Long-Run and Short-Run Coefficients of ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
Dependent Variable = PI				
Long-Run Results				
VEG	-1.469318	0.497479	-2.953529	0.0079
ELC	-0.521424	0.231435	-2.253005	0.0356
AEC	-0.770848	0.372599	-2.068839	0.0517
CES	0.130535	0.265010	0.492568	0.6277
C	68.54394	18.43165	3.718817	0.0014
EC = PI - (1.4693*VEG -0.5214*ELC -0.7708*ACE + 0.1305*CES + 68.5439)				
Short-Run Results				
D(PI(-1))	-0.340867	0.112821	-3.021320	0.0067
D(VEG)	-0.480993	0.135674	-3.545217	0.0020
D(VEG(-1))	-0.064088	0.125705	-0.509829	0.6158
D(ELC)	-0.401231	0.135940	-2.951529	0.0079
D(ELC(-1))	0.521424	0.158063	3.298825	0.0036
D(AEC)	-0.460060	0.228029	-2.017548	0.0573
D(CES)	0.121260	0.161184	0.752307	0.4606
CointEq(-1)*	-0.678388	0.126509	-5.362347	0.0000
R^2	0.578215			
Adjusted R^2	0.510730			
Durbin-Watson stat	2.154370			

Source: ***Author's Computation, 2024.***

Interpretation of Long-Run and Short-Run ARDL Model Results

Volume of Electricity Generated (VEG) and Poverty Index (PI)

Table 5 presents the long-run estimates of the ARDL model. The findings indicated that the amount of power produced has a negative and substantial correlation with the poverty index in Nigeria. The negative coefficient value (-1.469318) of power generation volume, together with its p-value (0.0079), which is below 0.05, substantiates this observation. An increase in the amount of power produced by a unit will result in a considerable long-term reduction of 1.469318 in the poverty index. The short-run estimations of the ARDL model indicated a negative and substantial correlation between the amount of power produced and the poverty index in Nigeria at the beginning level. The negative coefficient value (-0.480993) of power generation volume, together with its p-value (0.0020), which is below 0.05, substantiates this observation. An increase in the amount of power produced by a unit will result in a 0.480993 considerable reduction in the poverty index in the near term.

Electricity Consumed (ELC) and Poverty Index (PI)

The long-run estimates of the ARDL model indicate a substantial negative association between electricity use and the poverty index in Nigeria. The negative coefficient value of electricity consumption (-0.521424) and its p-value (0.0356), which above 0.05, provide proof for this observation. This indicates that an increase in electricity consumption by a unit will result in a substantial drop of 0.521424 in the poverty index over the long term. The short-run estimations of the ARDL model indicated that electricity consumption had a negligible negative long-run connection with the poverty index in Nigeria at the beginning level. The negative coefficient value of power consumption (-0.401231) and its p-value (0.0079), which is below 0.05, substantiate this observation. An increase in electricity use by a unit will result in a considerable drop of 0.401231 in the poverty index in the near term.

Access to Electricity (AEC) and Poverty Index (PI)

Furthermore, the long-run estimates from the ARDL model indicated that access to electricity had an insignificant negative long-term impact on the poverty index in Nigeria. The negative coefficient value of access to power (-0.770848) and its p-value (0.0517), which above 0.05, substantiate this observation. An increase in access to electricity by one unit will result in a 0.770848 negligible reduction in the poverty index over the long term. The short-run estimations of the ARDL model indicated that access to electricity had a considerable negative long-term impact on the poverty index in Nigeria. The negative coefficient value of access to power (-0.460060) and its p-value (0.0573), which above 0.05, substantiate this observation. An increase in access to electricity by one unit will result in a 0.460060 negligible reduction in the poverty index in the near term.

Carbon Emission (CES) and Poverty Index (PI)

The long-run estimations of the ARDL model indicated that carbon emissions had a non-significant positive long-run correlation with the poverty index in Nigeria. The positive coefficient value of carbon emission (0.130535) and its p-value (0.6277), which above 0.05, substantiate this observation. This indicates that a unit increase in carbon emissions will result in a negligible rise of 0.130535 in the poverty index over the long term. The short-run estimations of the ARDL model indicated that carbon emissions had a negligible positive long-run influence on the poverty index in Nigeria. The positive coefficient value of carbon emission (0.121260) and its p-value (0.4606), which above 0.05, provide proof for this assertion. An increase in carbon emissions by one unit will result in a negligible rise of 0.121260 in the poverty index in the near term.

Interpretation of CointEq(-1) Result

Table 5 presents the short-run dynamic coefficients related to the long-run relationships derived from the error correction model. The indicators of short-term dynamic interactions align with those of the long-term relationship. The computed error correction coefficient of -0.678388 (with a p-value of 0.0000) is highly significant, has the appropriate sign, and indicates a rapid adjustment to equilibrium after a disturbance. This indicates that around 68% of imbalances from the prior year's shock revert to the long-term equilibrium in the current year.

Interpretation of Adjusted R-Squared (Adj. R^2) Value

The Adjusted R-squared value of 0.510730 from the short-run estimates of the ARDL model in Table 5 indicates that the model is well-fitted, as systematic changes in the explanatory variables (volume of electricity generated, electricity consumed, access to electricity, and carbon emissions) account for approximately 51 percent of the variation in the poverty index, while the remaining 49 percent is attributed to factors outside the model.

Post-Estimation Tests

The results of the post-estimation tests are presented and discussed below:

Table 6: Post-Estimation Tests Results

Test	Null Hypothesis	X^2 Value	X^2 Prob	Remark
Jarque-Bera	Normal distribution exists	2.136556	0.224781	Normal residuals
Breusch-Godfrey LM	Serial correlation does not exist	1.331562	0.2889	Serial independence
Breusch-Pagan-Godfrey	Homoscedasticity exists	1.039966	0.0736	Constant Variance
Ramsey RESET	Model is stable	0.523884	0.4780	correctly specified model

Source: ***Author's Computation, 2024.***

The Jarque-Bera test results indicate that the model follows a normal distribution. The Breusch-Godfrey Serial Correlation LM test indicates that the model is free from serial correlation issues. The Breusch-Pagan-Godfrey heteroskedasticity test indicates that the model exhibits homoscedasticity. This indicates that relevant factors were not excluded. Finally, the Ramsey RESET test indicates that the model is appropriately described. This indicates that the model's functional form is accurate.

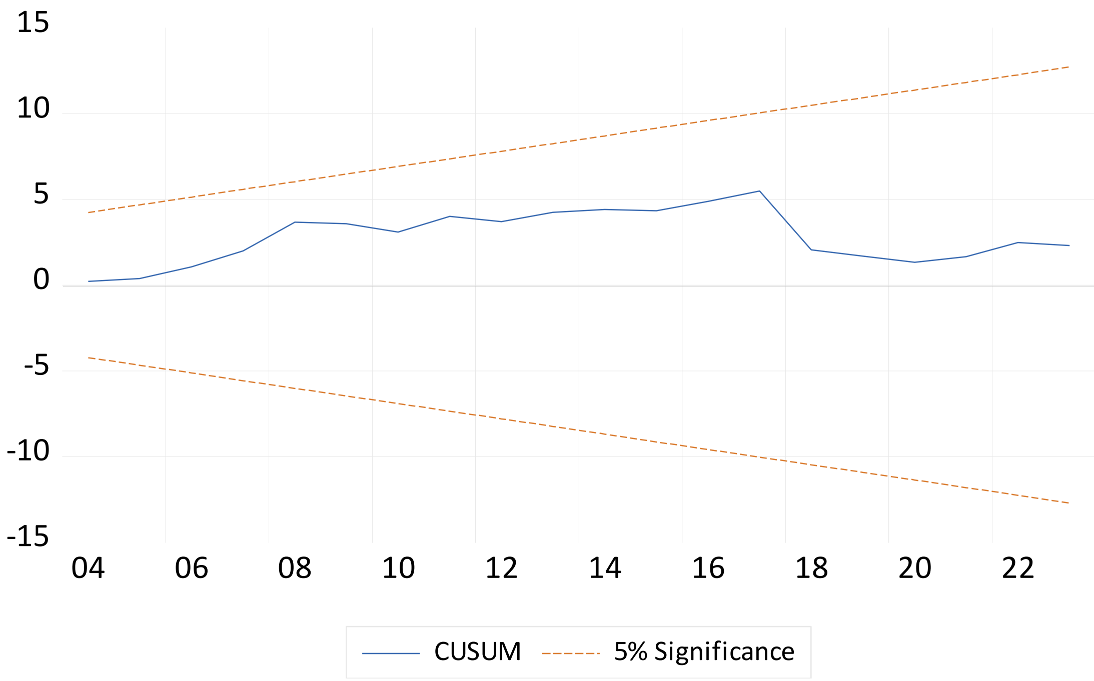

Figure 1: Stability Cusum Test

The cumulative sum (CUSUM) indicates that the CUSUM line stayed within the 5 percent critical bound while neither did CUSUM plot crosses the 5 percent critical lines. The implication of this is that there is stability of the long-run coefficients of the study variables.

Discussion

This work has empirically examined time series data to assess the impact of energy availability on poverty in Nigeria from 1990 to 2023, using the Autoregressive Distributed Lag (ARDL) estimate approach. The findings indicated that the amount of energy produced had a negative and substantial impact on the poverty index in Nigeria. An increase in power generation will significantly reduce the poverty index in both the long-term and short-term. The empirical findings of Okonkwo and Ogbonna (2018) indicate that the amount of power produced had a detrimental short-term effect on poverty in the Nigerian economy during the research period. Secondly, power consumption has a substantial negative correlation with the poverty index in Nigeria. This suggests that an increase in power consumption would result in a substantial reduction in the poverty index in Nigeria both in the long term and near term. This conclusion corresponds with the study of Oshota (2019), which indicated that access to energy and transportation infrastructure had a negative and statistically significant impact on both the incidence and depth of poverty reduction. Thirdly, access to electricity has a substantial negative impact on the poverty index in Nigeria. This suggests that enhanced access to electricity would result in a substantial rise in the poverty index in Nigeria both in the near term and the long term. The study's findings corroborated the results of Okwanya and Abah (2018), who identified a negative link between energy consumption and poverty levels. The study's findings on the relationship between energy access and poverty are consistent with those of Thiam (2011) and Diallo and Moussa (2020), which illustrated how energy improves quality of life and per capita household consumption in Senegal and Côte d’Ivoire, respectively. Ultimately, the findings from both the long-run and short-run estimations indicated that carbon emissions had a non-significant beneficial influence on the poverty index in Nigeria. This indicates that an escalation in carbon emissions would result in a negligible rise in the poverty index in Nigeria both in the long term and short term. The findings of this research opposed those of Girma, Girma, and Dereje (2015), who determined that electricity had a favorable and substantial effect on poverty reduction.

V. Conclusion and recommendations

Conclusion

This research objectively investigated the impact of electricity availability on poverty in Nigeria and found that: the volume of electricity generated, electricity consumed, and access to electricity significantly and negatively impacted on poverty index. This suggests that an increase in electricity generation, consumed and access to electricity will result in reduction of poverty in Nigeria. Based on this finding, the paper concluded that electricity generation, electricity consumed and availability of electricity substantially alleviated poverty in Nigeria.

Recommendations

The following recommendations are proffered based on the findings of this study:

i. To enhance electricity availability, policy must prioritize the enhancement of national grid infrastructure and the promotion of off-grid renewable energy options in distant and rural regions. Enhancing energy distribution and ensuring that produced power reaches a broader population may elevate productivity and foster the success of small-scale firms. This may alleviate poverty, since an increased number of individuals will participate in productive economic activities enabled by access to dependable energy.

ii. The government should promote more investment in power generation in order to improve access to electricity and reduce poverty in Nigeria. This could be done by investing more in renewable energy sources in order to promote energy diversification, improve access and reduce cost of energy in Nigeria.

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2.
3.

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