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Energy Poverty and Industrialization in Nigeria: An Econometric Analysis

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Abstract

This paper examined the relationship between energy poverty and industrialization in Nigeria between 1990 and 2021. Data from the World Bank, EIA, and NNPC were gathered and subjected to a unit-root test using the Augmented Dickey-Fuller test which showed that the variables in the model were of mixed order of integration. This bounds cointegration test also showed the existence of long-run relationships among the variables. The estimation result showed that energy poverty significantly impacts industrialization in Nigeria. The paper suggests that the Nigerian government should invest in policy and infrastructure that would improve electricity access and reduce energy poverty. The paper also suggests that the Nigerian government should encourage the optimal functionality of the refineries in the country

1. Introduction

Energy is a fundamental driver of economic growth and industrialization in any nation. Its availability, accessibility, and affordability are critical factors that can significantly impact a country's economic and development trajectory (Oliseeloke *et al*, 2023). Nigeria, the most populous country in Africa and one of its largest economies has immense potential for industrialization and economic expansion. Industrialization is a key driver of economic growth, job creation, and poverty reduction. However, achieving industrialization goals in Nigeria is contingent upon addressing the longstanding issue of energy poverty and reliability (Oyedepo, 2012).

Industrialization is a process through which a country's economy shifts from primarily agrarian to manufacturing and service-oriented activities. It is characterized by increased production, technological advancement, and urbanization. A crucial factor in this transformation is access to reliable and affordable energy. Energy powers machinery, facilitates research, and development, and supports a range of industrial processes (EIA, 2016). As such, it serves as the lifeblood of modern industries.

Despite its vast potential, Nigeria has faced persistent challenges concerning energy poverty. It has persistently failed to provide adequate and reliable electricity to its population. Factors contributing to this challenge include insufficient generation capacity, an antiquated transmission and distribution network, and high rates of electricity theft. According to the World Bank (2019), only approximately 55% of the Nigerian population had access to electricity, and even those with access often grapple with frequent power outages.

A reliable electricity supply is essential for industries to operate efficiently and remain competitive in domestic and international markets. Frequent power outages disrupt production processes, increase operational costs, and hinder productivity (Fakih *et al* 2020). Industrialization is a potent driver of employment. Expanding industries require a skilled workforce, and access to electricity is pivotal for skill development programs and training facilities. A broad industrial base in Nigeria would diversify the Nigerian economy away from its unhealthy dependence on the oil sector, making it more resilient to fluctuations in global oil prices. Energy poverty frustrates technological innovations critical for long-term industrial growth and economic development.

Addressing the energy poverty-industrialization nexus in Nigeria requires a comprehensive approach. Significant investments are necessary to expand and modernize the electricity generation, transmission, and distribution infrastructure. Public-private partnerships can mobilize the capital needed for these projects. Encouraging the adoption of renewable energy sources such as solar and wind power can help diversify the energy mix, enhance energy security, and reduce environmental impacts (Olarinde & Adeniran, 2018). Strengthening regulatory frameworks can attract private sector investments and improve the efficiency of the electricity sector.

Most existing literature provides a broad overview of how energy poverty affects industrialization at a macroeconomic level. However, sector-specific analyses would enable us to understand how energy poverty influences industries. For example, the manufacturing sector may experience distinct challenges and opportunities regarding its reliance on the energy sector compared to the agro-processing or information technology sectors.

The preceding paragraphs have enumerated the importance of energy access to establishing an industrial economy that would foster economic growth and development. However, nations need to engage in studies and research to determine the significance of energy poverty to industrialization as it would enable effective fiscal planning and investment in the energy sector. This is the motivation for this research and the null hypothesis position taken by this paper that says, energy poverty is significant for industrialization. The next part of this paper will engage in conceptual review and clarification on the topic. The paper will subsequently review the available literature on energy poverty and industrialization. The empirical method of analysis and the results will also be presented. The concluding part of this paper will explain the results and prescribe policy for the Nigerian government.

2. Literature Review

2.1 Theoretical Framework

This research is anchored on the Cobb-Douglas production function theory and the Neoclassical growth theory. The theories explore the relationship between different factor inputs and their contribution to productivity or output.

2.1.1 Cobb-Douglass Production Function

Cobb-Douglas production function theory was developed by Charles Cobb and Paul Douglas in 1928 and tested extensively. (Cobb & Douglas, 1928). It is a widely used economic model that describes the relationship between inputs (factors of production) and output (industrial production). It is often applied to analyze the role of electricity and other inputs in industrialization. The general form of the Cobb-Douglas production function is:

$Y = A \cdot L^{\alpha} \cdot K^{\beta} \cdot E^{\gamma}$

Where:

Y = industrial output.

A = the total factor productivity (TFP), which encompasses technological progress and efficiency.

L = the labor input.

K = the capital input.

E = the energy input (in this case, electricity)

α, β, γ are the respective output elasticities for labor, capital, and energy. They represent the share of each input in the production process.

In the context of Nigeria's industrialization, the Cobb-Douglas production function can be used to examine how energy poverty (E) influences industrial output (Y).

2.1.2 Neoclassical Growth Theory

Neoclassical growth theory, pioneered by economists like Solow and Swan in 1956 emphasizes the role of capital accumulation, technological progress, and productivity growth in driving economic development.

Neoclassical growth theory suggests that increasing the capital stock, which includes physical capital (machinery and infrastructure) and human capital (skills and knowledge), contributes to economic growth. In Nigeria, investments in electricity infrastructure and technological advancements supported by electricity can be seen as forms of capital accumulation that enhance industrialization. Technological progress is a key driver of economic growth in the neoclassical model. A reduction in energy poverty can fuel technological advancements in various industrial sectors. For instance, engaging in efficient mechanization and electricity-driven processes can lead to higher industrial output.

Neoclassical growth theory highlights the importance of increasing productivity to achieve sustained economic growth. Access to reliable energy can enhance the productivity of industries by reducing downtime due to power outages, leading to increased output per unit of input (Banton, 2020). The theory also recognizes the concept of diminishing returns to capital. As an economy accumulates more capital, the marginal productivity of capital decreases.

2.2 Energy Poverty in Nigeria

Nigeria has been plagued with energy poverty, which has not encouraged large-scale industrialization which would lead to economic growth and development. The major forms of energy for industrialization in Nigeria come in the form of electricity from the national grid, and petrol or diesel to run different forms of generators to produce private electricity. However, the electricity provided by the national grid is preferable for industrialization as it is cheaper than private generation and has the potential to handle more machinery than private production (this is peculiar to small and medium-scale enterprises). Given the priority placed on the electricity supply available from the national grid due to the factors above, this paper intends to use access to this electricity to underscore energy poverty for industrialization in Nigeria. An improvement in electricity access reduces energy poverty and vice-versa.

Electricity access is a multifaceted concept that encompasses the availability, affordability, reliability, and quality of electrical energy for individuals, communities, and industries. It is a fundamental component of modern life and plays a pivotal role in socio-economic development, impacting various aspects of human well-being and productivity (WEO-2017; IEA, 2017).

Availability of electricity is an aspect of access that addresses whether electricity infrastructure and supply networks exist and are accessible to a given population or region. (IEA, 2020). It includes the presence of power generation facilities, transmission lines, and distribution networks and ties into the extent of electrification, which can vary from urban to rural areas and across regions within a country.

Affordability is a critical dimension of access and concerns whether individuals and entities can financially afford electricity services. (United Nations, 2021). It takes into account the cost of electricity tariffs, connection fees, and the economic capacity of consumers to pay for electricity. Affordability ensures that electricity is accessible to a broad spectrum of society, including low-income households.

Reliability focuses on the consistency and stability of electricity supply. It considers the frequency and duration of power outages, voltage fluctuations, and interruptions in electricity service. A reliable supply is essential for businesses and industries to operate smoothly and maintain the quality of life for individuals

Nigeria has the lowest access to electricity globally, with about 92 million persons out of the country's 200 million population lacking access to power (Tracking SDG 7, 2023). Electricity access remains poor because electrification fails to keep pace with population growth. According to the World Bank, the electricity access rate in Nigeria stood at 55.4% in 2020 with a big gap between urban and rural areas (83.9% vs. 24.6%) (The World Bank, 2022). In areas where electricity is available, it often suffers from unreliability and frequent interruptions, commonly resulting in blackouts. According to the Nigeria Enterprise Survey conducted by the World Bank, approximately 27% of Nigerian firms cited the reliability of electricity supply as the main hindrance to their business. (World Bank, 2014). On average, 32.8 power outages were reported to occur in a typical month leading to an estimated 11% loss in sales value (Pelz, Chinichian et al).

The average grid-connected household receives just 6.6 hours of supply on a typical day, linked to a per capita consumption of just 144kWh per year. (World Bank, 2019b). Comparatively, the annual per capita consumption in Ghana and South Africa is respectively 351 kWh and 4,198 kWh. Plagued by issues of supply quality, many Nigerians have resorted to self-generation using petrol and diesel generators, spending approximately 1.56 trillion Naira (3.76 billion USD, using an average exchange rate in 2021) per year on fuel. (Ugwoke et al 2020).

2.3 Industrialization in Nigeria

Industrialization in Nigeria is a multifaceted process characterized by the transformation of the national economy from primarily agrarian and resource-dependent to one dominated by manufacturing and service industries. (Rasure, 2022). It involves the growth and expansion of various industrial sectors, technological advancement, and the development of a skilled workforce.

Industrialization entails reducing the over-dependence on a single sector, such as oil and natural resources, and diversifying into multiple sectors, including manufacturing, agriculture, construction, and services. This diversification aims to create a more resilient and balanced economy less susceptible to global commodity price fluctuations. Also central to industrialization is the growth of the manufacturing sector. (Chete, Adeoti, Adeyinka, & Ogundele, 2014). Manufacturing involves the transformation of raw materials and intermediate goods into finished products, creating value-added products for both domestic consumption and export. It is often seen as a key driver of economic growth and employment generation.

CBN (2022) showed a 3.2% share of manufacturing value in total gross domestic product (GDP) in 1960. In 1977, the manufacturing share of GDP rose to 5.4% then to 13% in 1992. It however fell to 6.2% in 1993, while the manufacturing capacity utilization (MCU) rate declined to 2.4% in 1998 and increased by 3.4% from 2001 to 2009. By 2020, value-added manufacturing as a percentage of the GDP reached 12.67% (The World Bank, 2023)

To improve the growth of the Nigerian economy, the government implemented some industrial policies such as the Structural Adjustment Programme (SAP) in 1986. This policy structure was an alternative framework to address the weaknesses and ineffectiveness of previous development planning efforts. The motives of these policies were to achieve economic growth, full employment, and balance of payment equilibrium. Economic growth is, however, a long-term expansion of the total productive potential of the economy (Kleynhans & Pradeep, 2013).

Over the years, Nigeria experienced great improvements in GDP, but with a high rate of poverty, unemployment, illiteracy, and low human development. Such growth is growth without development. It also shows that a large percentage of the population does not benefit from the expenditures of the government, which also leads to a decline in consumable goods.

The Nigerian industrial sector is characterized by high importation of industrial inputs, declining output, high production costs, diminishing capacity utilization, low value-added, low employment generation, and inadequate linkages to various sectors in the economy (Ijaiya & Akanbi 2009). The Nigerian government attempted to improve the growth of the economy by implementing some industrial policies like disinvestment, privatization, commercialization, devaluation, and SAPs. The main aims of these policies were to address the problems of economic growth, unemployment, the balance of payment deficit, technical progress, and technology transfer. After several attempts to stabilize the economy by different governments, the country experienced fluctuating growth.

It is clear from the review on industrialization that the activities of the manufacturing sector largely determine the level of industrialization in any economy. Given this reality, this paper will make use of manufacturing sector output to proxy industrialization in this paper to enable the collection of data for analysis.

2.4 Empirical Review

Ogundipe & Akinyemi (2014) in their paper "Electricity Consumption and Economic Development in Nigeria" examined the relationship between electricity consumption and economic development using an extended neoclassical model for the period 1970-2013. They incorporated the uniqueness of the Nigerian economy by controlling for the role of institutions, technology, emissions, and economic structure in the electricity consumption-development argument. The study adopted a cointegration analysis based on the Johansen and Juselius (1981) maximum Likelihood approach and a vector error correction model. To ensure robustness, the study adopted the Wald block endogeneity causality test to ascertain the direction of a causal relationship between electricity consumption and economic development. The study found the existence of a long-run cointegration equation with electricity consumption inversely related to economic development. Likewise, the vector error correction model failed to reject the null hypothesis of non-convergence in the long-run. Finally, the study found evidence supporting a unidirectional causal relationship running from economic development to electricity consumption.

Nwankwo & Chigozie (2013) in their paper "The Effect of Electricity Supply on Industrial Production Within the Nigerian Economy (1970 – 2010)" explored the links between sustained economic growth and electricity in an economy. They employed a multiple regression model to examine the effect of electricity supply on economic development and the effect of electricity supply on industrial development. The result of the regression shows that the electricity (ELEC), Gross fixed capital formation (GFCF), industrial production (INDU) variables, and population have positive signs. That is, they are positively related to RGDP Per capita. As a way of facilitating economic development, it is recommended that issues relating to electricity production and industrial development should be given priority, particularly in the budget scheme, and because of this, a substantial amount should be allocated to the electricity sector to be able to fix the state of electricity permanently.

Aminu & Aminu (2015) in their work "Energy Consumption and Economic Growth in Nigeria: A Causality Analysis" re-examined the causal relationship between energy consumption and economic growth using Nigeria's data from 1980 to 2011 in a multivariate framework by including labor and capital in the causality analysis. Applying the Granger causality test, impulse response, and variance decomposition analysis; the results of the causality test reported the absence of causality and that of variance decomposition found that capital and labor are more important in affecting output growth compared to energy consumption.

Chinedum & Nnadi (2016) in their work "Electricity Supply and Output in Nigerian Manufacturing Sector" explored the relationship between electricity supply and manufacturing sector's output in Nigeria. Time series data spanning the period between 1981 and 2013 were analyzed using Johansen Cointegration and Vector Autoregression tests. The results revealed that there exists a long-run relationship between electricity and manufacturing output in Nigeria. It also identified that electricity supply has an insignificant relationship with the manufacturing sector in Nigeria. For the Nigerian manufacturing sector to catalyze the transformation of the Nigerian economy, we recommend that an adequate and stable electricity supply must be a policy focus if the desired output of the manufacturing sector is to be achieved.

Matthew et al., (2018) examined the multiplier effect of human capital development through the usage of electricity power for maximum productivity to enhance economic growth in Nigeria. The study engaged data sourced from the World Development Indicators (WDI) for the period 1981-2016, and the Fully Modified Ordinary Least Squares (FMOLS) econometric method was engaged for the analysis. Results from the study showed that human capital development is insignificantly related to economic growth in Nigeria, while electricity consumption is significantly linked with economic growth. Therefore, the study recommended that there is a need for the government to develop human capital via the improvement of the educational and health facilities in the country as well as provide electricity in the rural and urban areas for maximum productivity.

Ike (2021) examined the relationship between monthly industrial output in Nigeria and available monthly power generation capacity, available monthly power transmission capacity, and monthly power distribution capability in his work "Impact of Electricity on Industrial Output in Nigeria: A Systems Perspective" Systems theory was the theoretical framework for the study. Data was collected on the monthly industrial output and operational data on electric utilities in Nigeria from 2015 to 2020 to constitute a population size of 72 months. The result indicated capacity incongruencies across the power supply value chain. Pearson's correlation analysis showed no statistically significant correlation between generation capacity and transmission capacity, and there was a negative but not statistically significant correlation between transmission capacity and distribution capability. The results of the multiple regression analysis indicate that the linear combination of the independent variables statistically significantly predicted industrial output in the regression model; however, only distribution capability had a statistically significant correlation with industrial output. He recommended policy development for improved electricity supply that will boost the competitiveness of local industries, leading to economic growth and reduced poverty.

Ibitoye, Ogunoye, & Kleynhans (2022) in their paper "Impact of Industrialization on Economic Growth in Nigeria", utilized the Johansen co-integration and Granger causality tests to determine the long-term relationship and causality among variables. They discovered that industrial output has a significant direct effect and an aggregate effect of 86% on the real gross domestic product (GDP). A unidirectional causal impact of industrial output on real GDP was also established. They recommended that the government should encourage more foreign direct investment through the adoption of industrialization policies such as tax holidays, provision of land for industrial uses to foreign investors, and ensuring that the lending interest rate for the real sector is lowered during low production to stimulate growth in the sector. The government should also increase the electricity supply, ensure green industrialization, encourage renewable energy consumption, and control the exchange rate that may stimulate industrialization and increase the growth of the economy.

The literature reviewed shows that there is no definite position on the impact of energy poverty on industrialization or economic growth in Nigeria and different economies. It is therefore important to engage in this research to determine the Nigerian reality as regards the relationship between energy poverty and industrialization in Nigeria.

3. Method of Analysis

An econometric model was formulated to evaluate and achieve the objectives of this study. This model was formulated based on the neo-classical growth theory and the Cobb-Douglas production function. This theory suggests that an increase in factor inputs would lead to an increase in output. This implies that an increase in electricity access should lead to an increase in industrialization and output. The algebraic model of the study is specified below:

MANC = F (ERCA, AGO, GDP) ………………………………………………………………………………………… (1)

The left side of Equation 1 above contains the dependent variable MANC. The right side of the equation contains the independent variables electricity access, AGO consumption, and Economic Growth. The equation simply implies that electricity access, AGO consumption, and economic growth will lead to an increase in manufacturing sector output in the economy.

Equation 1 above can be transformed into a mathematical form as specified below:

$$MANC = \alpha + \beta_1 ERCA + \beta_2 AGO + \beta_3 GDP \quad (2)$$

The mathematical model above will be transformed into its econometric form to make it useful for econometric analysis:

$$MANC_i = \propto_0 + \beta_1 ERCA_i + \beta_2 AGO_i + \beta_3 GDP_i + \mu_1 \quad (3)$$

The model in equation 3 will be further transformed into a log-linear form for estimation purposes and this is seen below:

$logMANC_i = \propto_0 + \beta_1 ERCA_i + log\beta_2 AGO_i + \beta_3 GDP_i + \mu_1$ ………………………………………… (4)

β1>0;β2>0;β3>0;

Where:

MANC refers to manufacturing sector output, ERCA is electricity access, AGO refers to AGO consumption, GDP is the growth rate of GDP and μ_1 is the white noise error term. $\propto_0$ is the constant of the equation, while β_1, β_2 *and* β_3 are the parameter estimators of ERCA, AGO, and GDP respectively.

Table 3.1: Data Source and Description

Variable	Description and Expected Sign	Data Source
Manufacturing Sector Output (MANC)	Manufacturing sector output refers to industrial net output of a sector after adding up all outputs and subtracting intermediate inputs. It is calculated without making deductions for depreciation of fabricated assets or depletion and degradation of natural resources. Data are in constant local currency.	World Bank national accounts data, and OECD National Accounts data files.
Electricity Access (ERCA)	Access to electricity is the percentage of the population with access to electricity.	IEA, IRENA, UNSD, World Bank, WHO. 2023. Tracking SDG 7: The Energy Progress Report. World Bank, Washington DC. © World Bank. License: Creative Commons Attribution—Noncommercial 3.0 IGO (CC BY-NC 3.0 IGO).
Automotive Gas Oil Consumption (AGO)	This is the amount of ado (Diesel) used to fuel generators, cars, and	World Bank national accounts data, and OECD National Accounts data files.

	machinery. It is measured in metric tons.	
Gross Domestic Growth Rate (GDP)	Annual percentage growth rate of GDP at market prices based on constant local currency. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for the depreciation of fabricated assets or for the depletion and degradation of natural resources.	World Bank national accounts data, and OECD National Accounts data files.

source: Authors Compilation

3.1 Estimation Procedure

This study made use of the Autoregressive Distribution Lagged method of estimation to determine the nature of the relationship that exists between energy poverty and industrialization in Nigeria. This estimation method, alongside other econometric tests, clearly outlined the short-run and long-run dynamics between Energy Poverty and industrialization in Nigeria. The Error Correction Mechanism (ECM) informed the model of the speed of convergence from the short-run to the long-run equilibrium. To ensure that the estimation results are not spurious, the Augmented Dickey-Fuller unit-root test was used to determine the nature of stationarity of the variables within the model. The bounds cointegration test was equally used to determine if there is a long-run equilibrium among the variables. Finally, the variables and the model were subjected to post-estimation tests (serial correlation test, autocorrelation test, and normality test) to determine the strength of the estimation result. A detailed analysis of the empirical result was done using the E-views10 statistical software.

3.2 Presentation of Results

This section of the paper will present the results of the different empirical tests conducted in this paper.

Table 3.2 below gives a detailed analysis of the Augmented Dickey-Fuller Unit root test result. The test was conducted to determine the level of stationarity of the different variables in the model.

Table 3.2: Augmented Dickey-Fuller Unit Root Test

	LEVEL		**FIRST DIFFERENCE**		
VARIABLES	**T-Stat**	**5% Crt. Value**	**T-Stat**	**5% Crt. Value**	**ORDER**
MANC	-2.397791	-3.568379	-3.738552	-3.568379	I(1)
ERCA	-6.510985	-3.562882			I(0)
AGO	-4.503230	-3.562882			I(0)
GDP	-3.541832	-3.562882	-8.881265	-3.568379	I(1)

Source: Authors Compilation

The table above presents the results of the unit root test for the study on the relationship between energy poverty and industrialization in Nigeria for the period of 1990 to 2021. The test statistics show that MANC and GDP are stationary after first differencing, while ERCA and AGO are stationary at level. The mixed order of integration among the variables in the model makes it necessary to test for the existence of long-run relationships among the variables (Shrestha and Bhatta, 2018). This is done using the bounds cointegration test and the result is presented below:

Table 3.2: Bounds Cointegration Test

F-Bounds Test — Null Hypothesis: No levels relationship

Test Statistic	Value	Signif.	I(0)	I(1)
			Asymptotic: n=1000	
F-statistic	5.247874	10%	2.37	3.2
K	3	5%	2.79	3.67
		2.5%	3.15	4.08
		1%	3.65	4.66
			Finite Sample:	
Actual Sample Size	29		n=35	
		10%	2.618	3.532
		5%	3.164	4.194
		1%	4.428	5.816
			Finite Sample: n=30	
		10%	2.676	3.586
		5%	3.272	4.306
		1%	4.614	5.966

source: E-views Output

The table above shows the result of the bounds co-integration test. The F-statistic value of 5.247874 is greater than the upper bound critical value of 4.306 at 5 percent. This result gives us reason to reject the null hypothesis of no long-run relationship among the variables in the model. This result also implies that there will be convergence in the long run among the variables. Given the result above, the paper will go on to provide the short-run and long-run estimation results.

Table 3.3: Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(MANC(-1))	0.552203	0.103948	5.312320	0.0000
D(MANC(-2))	0.151991	0.101633	1.495485	0.1497
D(GDP)	5.25E+10	1.15E+10	0.000000	0.0000
CointEq(-1)*	-0.218377	0.039072	-5.589038	0.0000
R-squared	0.785409	Mean dependent var		6.33E+10
Adjusted R-squared	0.759658	S.D. dependent var		3.90E+11
S.E. of regression	1.91E+11	Akaike info criterion		54.92066
Sum squared resid	9.16E+23	Schwarz criterion		55.10926
Log likelihood	-792.3496	Hannan-Quinn criter.		54.97973
Durbin-Watson stat	1.642672			

source: E-views Output

The R-square value is 0.785409, while the adjusted R-square value is 0.759658. This implies that approximately 79 percent of the variation in industrial sector output in Nigeria is associated with the dynamics of the variables in the model, while the remaining 21 percent is captured by the error terms. The Durbin-Watson statistic value of 1.642672 indicates the absence of first-order autocorrelation in the residual of the series. The error correction term of -0.218377 is adequately signed and statistically significant at 5 percent. This implies that the short-run disequilibrium will revert to the long run equilibrium at the speed of 21 percent annually.

In the short run, the coefficient value of the first-year lag of MANC has a positively significant influence on the dependent variable MANC. It is significant at 5% since the probability value of 0.0000 is less than the threshold of 0.05. Therefore, an increase in the one-year lag of the manufacturing sector output (MANC-1) by 1% will lead to an increase in the current value of manufacturing sector output by approximately 0.55% in the short run ceteris-paribus. In the short run, economic growth (GDP) also has a positively significant impact on manufacturing sector output MANC in Nigeria ceteris-paribus. This implies that a 1% increase in GDP would lead to approximately a 5.25+10% increase in MANC in the short run. Finally, the MANC after two years lags positively influences MANC in the current year, however, this relationship is insignificant.

Table 3.4: Long-run Estimation Result

Levels Equation
Case 2: Restricted Constant and No Trend

Variable	Coefficient	Std. Error	t-Statistic	Prob.
ERCA	2.93E+11	6.98E+10	4.191513	0.0004
AGO	7.57E+08	4.90E+08	1.545900	0.1371
GDP	-1.49E+11	6.60E+10	-2.260975	0.0345
C	-1.05E+13	4.12E+12	-2.559316	0.0183

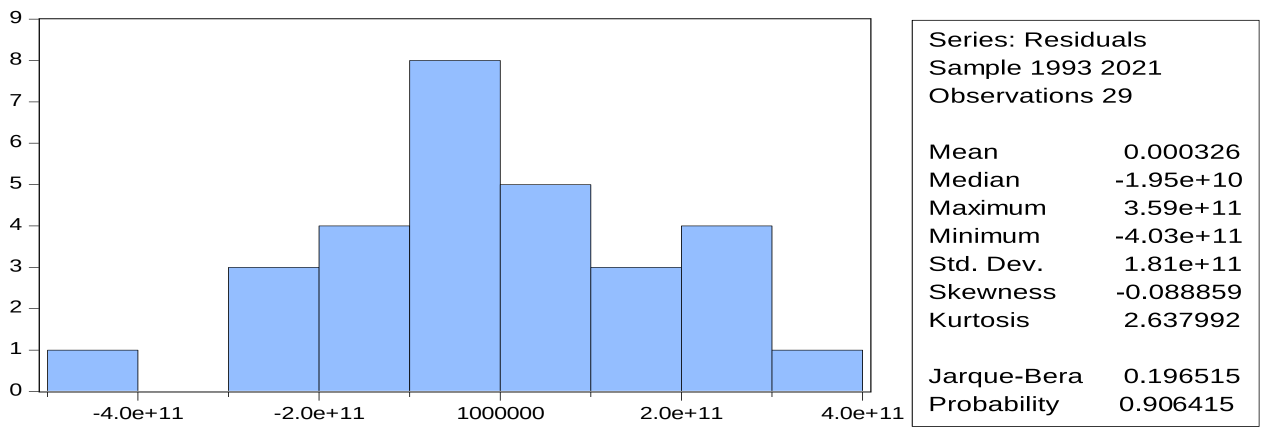
source: E-views Output

Table 3.4 shows the long-run result of the ARDL model used to determine the relationship between energy poverty and industrialization in Nigeria between 1990 and 2021. The result shows that ERCA has a positively significant impact on industrialization in Nigeria in the long run. This implies that a rise in electricity access would lead to an increase in industrialization in Nigeria. This result is in line with theoretical expectations. Consequently, if ERCA increases by 1 percent, industrial output will increase by approximately 2.93E+11 percent ceteris-paribus.

The result also shows that there is a positive but insignificant relationship between AGO consumption and industrialization in Nigeria between 1990 and 2021. However, GDP growth has a negatively significant impact on industrialization in Nigeria. Therefore, a 1 percent increase in the economy in terms of GDP will lead to a decline in industrialization in Nigeria by 1.49E+11 percent ceteris-paribus.

Post Estimation Test:

Jacque-Bera: Residual Normality Test



Source: E-views Output

To test the validity of the regression, the normality status of the regression residuals was tested. This test allows the researchers to determine if the estimated equation meets the assumptions of ordinary least squares. The Jarque-Bera statistic of 0.196515 and its probability value of 0.906415 assert that the residuals are normally distributed.

Breusch-Godfrey Serial Correlation LM Test:

F-statistic	0.256212	Prob. F(2,19)	0.7766
Obs*R-squared	0.761582	Prob. Chi-Square(2)	0.6833

Source: E-views Output

The Breusch-Godfrey Serial Correlation LM Test was used to test for the independence of the error term. The F-statistic value of 0.256212 and the observed R-square value of 0.76182 are statistically insignificant with the probability values of 0.7766 and 0.6833. These results gives us reasons to assert that there is no evidence of serial correlation in the residuals of this study.

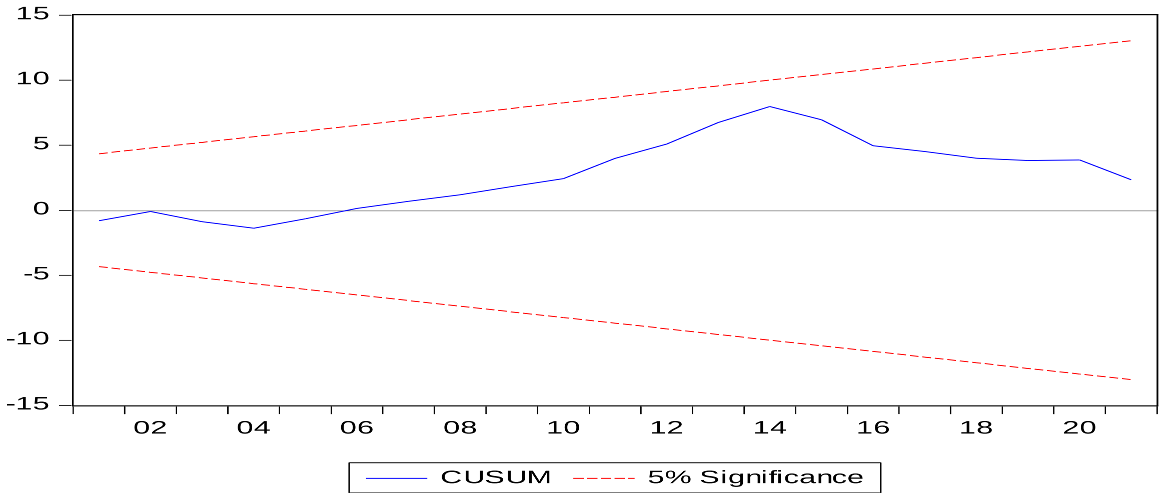
Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.779748	Prob. F(7,21)	0.6113
Obs*R-squared	5.982594	Prob. Chi-Square(7)	0.5418
Scaled explained SS	2.569295	Prob. Chi-Square(7)	0.9218

Source: E-views Output

In testing the equality if the variance of the residuals as required by the ordinary least squares assumption, the Breusch-Pagan-Godfrey heteroskedasticity test was employed. Given the F statistic value of 0.374439, the Obs*R-squared value of 5.982594 and the scaled explained SS value of 2.569295, their respective probability values are 0.6113, 0.5418 and 0.9218. Therefore, we concluded that there is no evidence of heteroskedasticity in the residuals.

Model Stability Test



Source: E-views Output

The cusum test was conducted to test model stability. The result of the estimation falls within the 95% confidence interval with approximately 5% error. This result is in line with the requirements of OLS assumptions.

Implications of Results

The estimation result shows that electricity access has a statistically positive and significant impact on industrialization in Nigeria. This means that the more access people in Nigeria have to electricity (the lower the energy poverty), the higher the value of manufacturing sector output and industrialization in Nigeria. This result is important as it underscores the importance of investment in the Nigerian electricity sector to the industrial sector and the economic growth in the country. However, in the short-run energy poverty does not impact industrialization. AGO consumption also positively impacts industrialization in Nigeria as it is the country's main alternative fuel for industrial power plants. This study implies that investments in the electricity sector of Nigeria, to increase electricity access in the country is critical to promoting industrialization and economic growth in Nigeria. The study also implies that the Nigerian government should put efforts into ensuring the optimal functionality of its petroleum refining sector to enable AGO production which is also a positive contributor to industrialization in Nigeria.

Conclusion/ Recommendations

The general objective of this paper was to examine the relationship between energy poverty and industrialization in Nigeria. The specific objective was to determine the relationship between electricity access and manufacturing sector output in Nigeria between 1990 and 2021.

To carry out the examination, data from the World Bank, NNPC statistical bulletin, and IEA database were collated and analyzed. The data were subjected to the augmented dickey-fuller unit-root test which informed the use of the ARDL estimation method. The investigation showed the existence of a long-run relationship among the variables in the model. The estimation results also showed that energy poverty significantly determines industrialization in Nigeria.

The result of the analysis moved the paper to propose that the Nigerian government enact policies that would encourage an increase in electricity access and crude oil refining in Nigeria. The benefits of industrialization are enormous as it would increase employment and competition in the productive sector which will reduce the inflation rate and consequently lead to economic growth.

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