Does Energy Utilisation Reduce Unemployment? The Nigeria's Experience

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ABSTRACT

This study empirically determined the effect of energy utilisation on employment in Nigeria over the period 1990 – 2022 using time series data. The study utilized data on: renewable (hydroelectric), nonrenewable (petroleum oil and natural gas), energy consumption and unemployment rate sourced from the Central Bank of Nigeria Statistical Bulletin, World Development Indicator (WDI) and the International Energy Association (IEA). This study adopted cointegration and error correction mechanism (ECM) methodology to investigate the relationship between the energy consumption and unemployment rate. Findings from the study shows that the utilisation of renewable energy resource like hydro power, had a substantial adverse effect on unemployment rate. Conversely, the use of nonrenewable energy sources, petroleum oil and natural gas, had a substantial positive effect on unemployment rate in Nigeria. Based on the findings, the study therefore concluded that there exists a variation in the impact of energy consumption on unemployment rate, in Nigeria. Consequent upon these findings, the study suggested improve investment in power generation that supports the integration of renewable energy into the national grid and reduction in transmission power losses during transmission in order to improve power supply, improve investment and creation of more job opportunities for the teeming unemployed youths in Nigeria.

Key words: Energy utilization, Renewable Energy, Non-renewable Energy and Unemployment rate

INTRODUCTION

Energy is a crucial and necessary resource in the economy. All facets of economic operations on Earth need energy in various forms to function efficiently. Energy is an essential element of human society, and its importance has increased significantly during the last decade. It acts as a crucial element in fostering sustainable corporate, economic, and fiscal advancement, both globally and specifically for emerging countries such as Nigeria. According to Enu and Havi (2014) and Umeh, Ochuba, and Ugwo (2019), nations with lower energy consumption and per capita distribution are seen as less industrialized and economically weaker. Energy consumption is a vital driver of economic progress and growth, powering industry, transportation, and families worldwide. Nonetheless, reliance on non-renewable energy sources has resulted in significant environmental consequences, exacerbating issues such as air and water pollution, deforestation, and climate change. As the global population grows and industrializes, the need for energy escalates, resulting in a heightened impact on the environment (Haliru, 2023). Wajid, Solomon, Ibrahim, and Bezon (2022) characterize energy consumption as the application of energy across diverse activities, including power generation, transportation, heating, and industrial operations. Fossil fuels, including coal, oil, and natural gas, have historically served as the predominant global energy sources due to their abundant availability, economic efficiency, and high energy density. Fossil fuels, namely coal and natural gas, have been the primary sources of energy consumption in Nigeria. During the first phase of the nation's development, coal served as the primary energy source. From 1990 to 2000, there was a significant decrease in coal use for electricity production. Coal use increased from 2000 to 2015, peaking about 2018 before seeing a modest decline. Coal was found in Nigeria in 1909 at Enugu, with first production commencing in 1916. Approximately 24,500 tons of coal were generated and used for mass railway transit, hence enhancing energy generation and industrial operations. Currently, over 80% of electrical production is derived from gas, but other sources include oil, with Nigeria being the predominant user of oil-fired backup generators in Africa. Natural gas continues to be the primary

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energy source in the AC, while there is a transition towards solar photovoltaic technology as the nation begins to harness its substantial solar potential (IEA, 2019). Presently, the Nigerian Electricity Supply Industry (NESI) operates 23 grid-connected generating facilities, boasting a total installed capacity of 11,165.4 MW and an available capacity of 7,139.6 MW. The majority of generating is thermal-based, with an installed capacity of 9,044 MW (81% of the total) and a usable capacity of 6,079.6 MW (83% of the total). Hydropower from three major facilities constitutes 1,938.4 MW of total installed capacity, with an available capacity of 1,060 MW. The real energy supply has been markedly insufficient compared to load demand; specifically, in 2014 and 2016, the actual supply fell short of power demand by 21,639 MW and 23,401 MW, respectively, accounting for about 15% and 17% of power availability. Consequently, there is no proportional rise in energy output matching to population growth, as seen in 2014 when the country's population reached 165 million, while the total power produced remained at 3,795 MW (Babatunde & Shauibu, 2011). Nigeria now ranks among the most underpowered nations globally, with real consumption falling 80% short of projections based on its population and income levels. Self-generation in Nigeria is very widespread, with around 14GW of capacity in small-scale diesel and petrol generators. Nearly half of all energy used is self-generated, indicating a substantial unfulfilled need. This scenario illustrates that Nigeria's energy use gap is considerable, but the precise magnitude remains contentious. The substantial discrepancies in these estimations illustrate the challenges and significance of precise demand forecasting. The inadequate power generation has hindered economic operations, leading to sluggish economic development, increased unemployment, and escalating costs of products and services, all of which have contributed to a decline in the living standards of the typical Nigerian. As of 2023, the unemployment rate in Nigeria was 5.3%. This research aims to investigate the effect of energy use on the unemployment rate in Nigeria. The research specifically investigated the impact of hydroelectric power, petroleum oil, and natural gas on the unemployment rate in Nigeria.

LITERATURE REVIEW

Theoretical Framework

This research is based on Energy Transition Theory. Hosier and Dowd (1987) and Leach (1992) introduced the Energy Transition hypothesis, which correlates energy use with income levels. The objective of energy transition theory is to shift from conventional fossil fuel-based energy sources to more sustainable, renewable alternatives, offering a framework for analyzing and understanding this process. This theory emphasizes cleaner, more efficient, and environmentally sustainable energy systems, while exploring the dynamics, challenges, and possible advantages of this shift. Energy transition theory seeks to elucidate the complex interactions and transformations occurring within energy systems throughout time by integrating several dimensions, including technological, economic, social, political, and environmental factors. Energy is often regarded as a crucial driver of the contemporary economy, especially in countries that have had significant growth in recent years. The idea clarifies that a nation's energy consumption pattern is highly responsive to its per capita income. This concept, informed by consumer theory, posits that as disposable money increases, individuals will transition from using outdated, inefficient energy sources to more contemporary, handy alternatives. It is posited that nations with greater incomes use superior quality energy compared to countries with lower incomes, in agreement with this concept. The lack of access to contemporary energy sources impedes a nation's potential to alleviate poverty and attain sustainable development, in accordance with the Energy Transition idea. Energy deprivation impedes productivity and constrains economic activity; hence, maintaining energy access is essential for poverty alleviation efforts (Pachauri & Spreng, 2004; Kaygusuz, 2011; Sovacool, 2012). Key components of the energy transition hypothesis include: Transition Drivers: Renewable and sustainable energy sources are rapidly becoming standard, in accordance with energy transition theory. Factors that may promote the adoption of clean energy include technological advancements, cost reductions, resource scarcity, environmental issues, climate change initiatives, policy incentives, regulatory frameworks, market dynamics, consumer preferences, and social movements. Forecasting and facilitating energy transitions requires comprehension of the interplay among these factors.

Technological innovation is a crucial driver of energy transitions, enabling new methods of renewable power production, energy storage, smart grid infrastructure, efficiency improvements, and alternative fuels.

Advancements in renewable energy sources, such as solar, wind, hydropower, geothermal, and biomass, have accelerated the shift from fossil fuels to more viable and competitive alternatives.

Financial Factors: Economic factors affect energy transitions by shaping fiscal viability, investment appeal, and cost competitiveness of different energy options. Renewable energy is becoming competitive in cost with conventional fossil fuels due to declining technological expenses, reduced pricing of renewable energy supplies such as wind turbines and solar panels, and expanding economies of scale. Carbon pricing methods, subsidies, tax credits, and economic incentives may accelerate the transition from fossil fuels and promote investment in renewable energy.

Policy and Regulation: Policy and regulatory frameworks significantly influence energy transitions by delineating objectives, criteria, incentives, and regulations that encourage the use of renewable energy sources while discouraging fossil fuel utilization. Renewable portfolio standards, feed-in tariffs, tax incentives, emission reduction targets, and carbon pricing mechanisms exemplify policies that encourage clean energy investment and implementation by providing market signals. International agreements, such as the Paris Climate Accord, influence energy transition pathways by setting global objectives and commitments to reduce greenhouse gas emissions.

Societal and Cultural Influences: The methods by which energy transitions take place and their resultant effects are influenced by societal perceptions, cultural norms, public awareness, and the acceptance of energy and environmental issues. Fostering public support and confidence for renewable energy initiatives and infrastructure development requires public engagement, educational campaigns, community involvement, and stakeholder collaboration. Grassroots initiatives, lobbying organizations, and social movements may mobilize the public and exert pressure on legislators to prioritize renewable energy and sustainability.

Environmental Necessities: transition to sustainable energy systems to tackle urgent environmental issues, such as mitigating air and water pollution, safeguarding biodiversity, and preserving limited resources should be promptly initiated. This is because the combustion of fossil fuels jeopardizes ecosystems, human health, and the global climate system by contributing to air pollution, environmental degradation, and greenhouse gas emissions. To mitigate these detrimental environmental impacts and achieve sustainability objectives over time, it is essential to transition to renewable energy and use energy efficiency strategies.

Empirical Review

Apergis and Salim (2015) advanced the discourse on the dynamic relationship between renewable energy consumption and unemployment by the use of nonlinear cointegration and causality analysis. Utilizing a sample of 80 nations from 1990 to 2013 and employing sophisticated methodologies for unit root, cointegration, and nonlinear Granger causality in panel data, we derive inconclusive conclusions about the effect of renewable energy use on unemployment. The overall findings indicate a beneficial impact of renewable energy consumption on unemployment; however, region-specific data from Asia and Latin America reveal that the effect on job creation is contingent upon the costs associated with adopting renewable energy technologies and energy efficiencies, which appear to differ across the examined regions. Bulavskaya and Reynès (2017) analyzed the effect of renewable energy on employment generation in the Netherlands using a neo-Keynesian CGEM Three-ME model. The authors found that the shift to renewable energy may generate around 50,000 jobs by 2030, therefore contributing 1% to GDP.

Khodeir (2016) identified an inverse association between renewable power generation and the unemployment rate in Egypt from 1989 to 2013 via the ARDL methodology. The research sought to identify the impacts in both the short and long term during the study period; however, it was determined that the hypothesis was only validated in the long term.

Bekmez and Ağpak (2016) examined the correlation between non-hydro renewable energy and employment across a panel of 80 countries, concluding that there exists a unidirectional causality from employment to non-hydro renewable energy consumption in low to middle-income countries, while no causality is observed in high-income countries. The data thus provide little evidence to support the idea that renewable energy positively affects unemployment.

Rivers (2013) analyzed the effect of renewable power assistance programs on the equilibrium unemployment rate using a three-sector general equilibrium model. The research indicated that measures supporting renewable power result in a rise in unemployment rates. Nonetheless, the analysis delineates circumstances in which renewable energy support programs might mitigate the equilibrium unemployment rate. When the elasticity of substitution between capital and labor is low, capital is globally immobile, and the labor intensity of renewable generating is high compared to conventional generation, renewable power assistance programs may decrease the unemployment rate.

Ragwitz et al. (2009) determined that EU-wide renewable energy regulations had produced a net beneficial effect on employment using an input-output framework and a macromodel. Lehr et al. (2008) examined the correlation between renewable energy and unemployment in Germany, concluding that the net impact of renewable energy on unemployment is positive.

Rafiq et al. (2018) examined the interrelations of sectoral economic activity, macro spending trends, renewable and non-renewable energy consumption, and unemployment across 41 countries from 1980 to 2014. Advanced econometric methodologies, including both linear and non-linear panel and time series estimate approaches were used. The findings indicate that industrialization, the services sector, government spending, and trade openness contribute positively to the reduction of unemployment, but agriculture and renewable energy use exacerbate unemployment levels. This may be partially attributable to recent technology improvements and substantial financial expenditures in the agricultural and renewable energy industries.

Khobai et al. (2020) investigates the correlation between renewable energy usage and unemployment in South Africa from 1990 to 2014. The autoregressive distributed lag model was used to examine the long-term and short-term effects of renewable energy consumption on unemployment. The findings indicate that renewable energy usage adversely and significantly impacts unemployment in the long term. Nonetheless, in the short term, the variables exhibit a negligible association.

Yılancı et al. (2020) presented a cointegration test accommodating structural breaks, where the quantity, position, and nature do not compromise the test's precision, to analyze the long-term relationship between unemployment rates and renewable energy consumption in selected OECD countries. The findings indicate a cointegration connection among the variables for Australia, Austria, Chile, France, Germany, Japan, Mexico, Portugal, Spain, and the United States. The findings indicate that renewable energy consumption has a beneficial impact on unemployment rates in Austria, Portugal, and Spain, but it adversely impacts unemployment rates in Australia, Chile, France, Germany, and Japan.

Payne (2009) examined the correlation between energy consumption and employment in Illinois from 1976 to 2006 using the Toda-Yamamoto causality test, revealing a positive and statistically significant one-way causation from energy consumption to employment.

Blazejczak et al. (2014) used a sectoral energy-econometric model to evaluate the employment impacts of renewable energy subsidies in Germany. The authors determined that the net employment impacts of renewable energy development are modest but favorable, with the magnitude of these benefits contingent upon the labor market's circumstances and regulations.

Lund (2009) emphasized the significance of exports in the favorable correlation between renewable energy support policies and employment via the use of the input-output technique. The analysis indicated that in nations where investments in renewable energy contributed to job creation, employment rose in sectors producing renewable energy technology and their byproducts for export rather than for local use. Rivers (2013) used a basic analytical general equilibrium model to examine the correlation between renewable energy support programs and the unemployment rate. Rivers contends that subsidies promoting renewable energy and tariffs imposed on conventional power companies to discourage fossil fuel usage would increase the unemployment rate. Specifically, renewable energy support policies may decrease the unemployment rate

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when the substitutability between capital and labor is constrained, the international mobility of capital is restricted, and the expense of renewable electricity production methods is elevated compared to labor costs. Ragwitz et al. (2009) assessed a net beneficial impact of renewable energy assistance programs on employment across the EU. They used an input-output model in conjunction with a macroeconomic model. Kuster et al. (2007) analyzed the impact of renewable energy investment incentives in EU nations on many economic variables, including employment levels, using a multi-sectoral, multi-regional general equilibrium model. The authors disclosed that renewable energy subsidies increased the unemployment rate in the analyzed nations.

Gonzalez et al. (2005) discovered that renewable energy usage had a favorable impact on unemployment in the EU and Africa. Upandhyay and Pahuja (2010) evaluated the prospective employment generated by renewable energy technologies in India, particularly in wind and solar energy sectors. Germany and China are the two most advanced nations in the wind power industry. Zhao and Luo (2017) shown that the usage of renewable energy has elevated the employment rate in China. GWEC (2015) concentrated on the rise in employment in Germany attributable to renewable energy consumption and investments. Renewable energy, a sector conducive to innovation, fosters sustainable economic growth via its impact on employment in Europe (EREC, 2004).

The study indicates that both theoretical and empirical studies concerning the impact of energy use on the unemployment rate have been conducted both inside and outside Nigeria. Nevertheless, the majority of the research reviewed did not investigate the combined impact of renewable and non-renewable energy use on job creation and unemployment rates. Furthermore, to the best of the researcher's knowledge, the majority of these studies did not use the most current yearly time series data. This research examined Nigeria, an energy-rich nation in Africa, to analyze the comparative impact of renewable and non-renewable energy consumption on the unemployment rate, using current data.

METHODOLOGY

Annual time series data were obtained from secondary source like the World Bank, the Africa Energy Portal (AEP), the Central Bank Statistical Bulletin, and the International Energy Agency (IEA) for this research. Specifically, the Cointegtation and Error Correction Method were used to analysed estimate the effect of energy utilized on unemployment rate in Nigeria after conducting summary statistics and Unit roots test. The study modeled the impact of energy use on the unemployment rate in Nigeria, drawing upon the research of Gonzalez et al. (2005) and Upandhyay and Pahuja (2010), with minor modifications to the variables. The research posits that unemployment is a result of energy consumption:

$$UEMP_t = f(\beta_0, HEC_t^{\beta_1}, POC_t^{\beta_2}, NGC_t^{\beta_3}, GEXP_t^{\beta_4}, CPS_t^{\beta_5}, TOPEN_t^{\beta_6}, EXCR_t^{\beta_7}) \qquad 1$$

The estimation form of the model for examining the impact of energy consumption on unemployment rate in Nigeria is as follows:

$$\begin{aligned} LOG(UEMP_t) = \beta_0 + \beta_1 LOG(HEC_t) + \beta_2 LOG(POC_t) + \beta_3 LOG(NGC_t) + \beta_4 LOG(GEXP_t) \\ + \beta_5 LOG(CPS_t) + \beta_6 LOG(TOPEN_t) + \beta_7 LOG(EXCR_t) + \mu_t \end{aligned} \qquad 2$$

Where: $LOG(UEMP_t)$= Natural logarithm of Unemployment Rate, $LOG(HEC_t)$= Natural logarithm of Hydroelectricity Consumption, $LOG(POC_t)$= Natural logarithm of Petroleum Oil Consumption, $LOG(NGC_t)$= Natural logarithm of Natural Gas Consumption, $LOG(GEXP_t)$= Natural logarithm of Total Government Expenditure, $LOG(CPS_t)$ = Natural logarithm of Credit to the Private Sector, $LOG(TOPEN_t)$= Natural logarithm of Trade Openness, $LOG(EXCR_t)$ = Natural logarithm of Exchange Rate, β_0 = Intercept of the model, $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5, \beta_6, and\ \beta_7$= are the parameter estimates of the independent variables, A priori expectation = $\beta_1 < 0$, $\beta_2 < 0$, $\beta_3 < 0$, $\beta_4 < 0$, $\beta_5 < 0$, $\beta_6 < 0$, and $\beta_7 < 0$. μ_t = error term (represents the omitted variables in the model)

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Unit Root Test

Initially, it is essential to ascertain if the fundamental processes that produced the data series may be regarded as time-invariant. In the case of a non-stationary process, it is often challenging to depict the time series using equations with constant coefficients (Pindyck & Rubinfeld, 1998). We used the Augmented Dickey-Fuller (ADF) test for its robustness, simplicity, and user-friendliness (Gujarati & Porter, 2009). We further used the Phillips-Perron test to supplement the Augmented Dickey-Fuller unit root test. We designate this as:

$$y_{it} = \alpha_0 + \alpha_1 y_{it} + \beta_1 \sum_{i=1}^{n} \Delta y_{it-n} + \mu_i \qquad 3$$

where y_i = individual variables in the model, $\alpha_0, \alpha_1, and\ \beta_1$ = parameters of the model, each variable becomes stationary, if it is integrated at order zero {I(0)}, or else it becomes stationary at order in which it is differenced {I(d)} (Gujarati, 2003).

Cointegration tests

The reason for using cointegration theory comes from the fact that a lot of macroeconomic and financial time series are non-stationary. Before we focus on cointegration, Lardic and Mignon (2002) highlight four main properties of integrated series:

- If $X_t \sim I(d)$ then $a + bX_t \sim I(d)$ where a and b are constants with $b \neq 0$.
- If $X_t \sim I(0)$ and $Y_t \sim I(0)$ then $aX_t + bY_t \sim I(0)$ where a and b are constants.
- If $X_t \sim I(0)$ and $Y_t \sim I(1)$ then $aX_t + bY_t \sim I(1)$ where a and b are constants.
- If $X_t \sim I(d_1)$ and $Y_t \sim I(d_2)$ then $aX_t + bY_t \sim I(\max(d_1, d_2))$ where a and b are constants.

Definition and properties

We can define cointegration as follows:

If X_t and Y_t are both I(d), then the linear combination z_t :

$$z_t = X_t - aY_t \qquad 4$$

is also I(d).

However, it is possible that z_t is not I(d) but I(d-b) where b is a positive integer.

In this case, X_t and Y_t are said to be cointegrated. a is the cointegration coefficient and the vector[1, - a] is the cointegration vector.

The most studied case is when d = b = 1. It means that two non-stationary series I(1) are cointegrated if a stationary linear combination I(0) of those two series exists.

Lardic and Mignon (2002) give an intuitive explanation of cointegration:

"In the short term, X_t and Y_t can have both divergent evolutions (both are non-stationary), but they evolve together in the long term. Then, a stable relationship on the long-run exists X_t and Y_t. This relationship is called cointegration relationship or long-term relationship. It is given by $X_t = aY_t$ (assuming z_t = 0). In the long-run, similar movements of compensate in order to have a stationary series. Then z_t measures the magnitude of the disequilibrium between X_t and Y_t is called the equilibrium error."

Given that integrated variables of order 1, I(1), may exhibit a cointegration connection, many approaches facilitate the examination of such interactions. If all variables in a group are integrated of the same order and at least one linear combination of these variables is stationary, then the variables are cointegrated. Such variables are characterized by their tendency to remain closely aligned, with a long-term link drawing them together. Testing for cointegration partnerships entails examining the presence of a long-term connection. This thesis employs two distinct methodologies: the Engle and Granger methodology (1987) and the Johansen process (1991).

Error Correction Mechanism (ECM)

Granger (1981) articulated a theorem to associate cointegration with error correction models. This theorem asserts that variables cointegrated of order (1,1) may be represented by an error correction model. This theorem is assumed without question; however, its proof is available in Granger (1981) and Engle and Granger (1987).

Error correction models (ECMs) facilitate the modeling of modifications that result in a long-term equilibrium state. These are dynamic models including both short-term and long-term variable evolutions.

Assuming X_t and Y_t are two cointegrated variables CI, (1, 1). The ECM can be written as:

$$\begin{cases} \Delta X_t = \gamma_1 z_{t-1} + \sum_i \beta_i \Delta X_{t-i} + \sum \delta_j \Delta Y_{t-j} + d_1(L)\varepsilon_{X_t} \\ \Delta Y_t = \gamma_2 z_{t-1} + \sum_i \beta_i^{'} \Delta X_{t-i} + \sum \delta_i^{'} \Delta Y_{t-j} + d_2(L)\varepsilon_{Y_t} \end{cases}$$

Where:

- ε_{X_t} and ε_{Y_t} are white noises,
- $z_t = X_t - aY_t$ is the residual of the cointegration relationship between X_t and Y_t
- d_1 and d_2 are (L) finite polynomial.

The error correction model describes an adjustment process. It includes two types of variables:

- Variables in first difference (stationary) which represents short-term movements.

- Variables in level (z_t here) which are a stationary linear combination of non-stationary variables and assure the long-term movements.

RESULTS AND DISCUSSIONS

Table 1: The results of summary statistics for variables selected for the study

S/N	Variables	Mean	Median	Std. Dev	Min	Max
1	Hydroelectricity Consumption (kWh) (in '000)	23.37	21.81	4.53	15.79	34.78

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2	Petroleum Oil Consumption Barrel per day ('000)	626.88	515.28	232.06	332.63	1005.84
3	Natural Gas Consumption Cubic Metric tonnes ('000)	161.96	163.06	22.13	125.14	208.44
4	Unemployment Rate(%)	4.16	3.90	0.66	3.70	6.00
5	Government Expenditure (Trillion Naira)	3.547	2.038	3.833	0.060	14.946
6	Credit to the Private Sector (Trillion Naira)	9.341	2.290	11.304	0.034	39.012
7	Trade Openness (%)	0.25	0.26	0.19	0.01	0.73
8	Exchange Rate (Naira to USD)	146.55	129.22	116.64	8.04	425.97

Moreover, the mean natural gas consumption throughout this time is roughly 161.96, indicating a central trend of the data. The median number is around 163.06, signifying that fifty percent of the consumption levels fall below this threshold while the other fifty percent exceed it. The standard deviation is around 22.13, indicating the variability or dispersion of the consumption levels relative to the mean. The least consumption amount is 125.14, while the highest is 208.44. This range (83.30) indicates the disparity between the minimum and maximum consumption years. The data indicates a consistent increasing trajectory, accompanied by substantial gains over time. For instance, the figure increased from 125.14 in 1990 to 208.44 in 2022, indicating a growing dependence on natural gas. Significant variations exist; however, the overarching trend is favorable. Stability and modest increases are seen, with some years exhibiting more pronounced climbs, especially in recent times. The average unemployment rate over this time is roughly 3.94%. This denotes the core trend of the data. The median unemployment rate is around 3.90%, signifying that half of the unemployment rate numbers fall below this threshold while the other half exceed it. The standard deviation is around 0.52%, indicating the variability or dispersion of the unemployment rate numbers relative to the mean. The minimal unemployment rate is 3.70%, while the highest is 6.00%. This range (2.30%) indicates the disparity between the minimum and maximum unemployment rates documented during the period. The data exhibits positive skewness, indicating a greater frequency of lower unemployment rates relative to higher rates, with a few outliers elevating the overall numbers.

Econometric Analysis

Unit Root Analysis

Table 2: The Results of Unit Root Test

Variables	**Augmented Dickey-Fuller (ADF) Test**			
	Constant (p-value)	Constant & Trend (p-value)	None (p-value)	Status
LOG(UNEMP)	-3.63** (0.012)	-4.01** (0.02)	-3.69*** (0.001)	I (1)

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LOG(HEC)	-6.55*** (0.000)	6.43*** (0.000)	6.54*** (0.000)	I (1)
LOG(POC)	-6.65*** (0.000)	-6.67*** (0.000)	-6.65*** (0.000)	I (1)
LOG(NGC)	-4.52*** (0.000)	-4.31*** (0.000)	-4.42*** (0.007)	I (1)
LOG(GEXP)	-8.22*** (0.000)	-9.65*** (0.000)	-2.11** (0.036)	I (1)
LOG(CPS)	-4.13*** (0.000)	-4.80*** (0.000)	-2.32** (0.022)	I (1)
LOG(TOPEN)	-5.85*** (0.000)	-6.19*** (0.000)	-5.00** (0.022)	I (1)
LOG(EXCR)	-5.24*** (0.000)	-5.34*** (0.001)	-4.53** (0.022)	I (1)

Table 2 displays the results of the unit root testing. The "Status" column in each test specifies the sequence of integration. The ADF test indicates that all eight variables are integrated of order one. The PP test reveals that trade openness and exchange rate are stationary at order zero, whereas the other six variables are stationary at order one. Consequently, save from real GDP, which needed two differencing operations to gain stationarity, all other variables achieved stationarity after a maximum of one differencing under both the Augmented Dickey-Fuller (ADF) and Phillips-Perron (PP) tests.

Cointegration Analysis

Table 3: Results of the Johansen Cointegration Test

Trace Test				**Maximum Eigenvalue Test**		
Hypothesized No. of CE(s)	Trace Statistic	0.05 Critical Value		Hypothesized No. of CE(s)	Max-Eigen Statistic	0.05 Critical Value
None *	258.2708	159.5297		None *	87.25561	52.36261
At most 1 *	171.0152	125.6154		At most 1 *	64.30095	46.23142
At most 2 *	106.7142	95.75366		At most 2	38.61988	40.07757
At most 3	68.09437	69.81889		At most 3	30.42423	33.87687
At most 4	37.67014	47.85613		At most 4	17.94693	27.58434
At most 5	19.72321	29.79707		At most 5	15.68102	21.13162

At most 6	4.042188	15.49471		At most 6	4.008763	14.26460
At most 7	0.033425	3.841465		At most 7	0.033425	3.841465
Note: * denotes rejection of the hypothesis at the 0.05 level **Source**: Author's computation, 2024.						

Table 3 illustrates the results of the Johansen cointegration test for the unemployment rate model, encompassing both the Trace and Max-Eigen test statistics. The Trace test reveals three cointegrating equations at the 0.05 significance level. Similarly, the Max-Eigen test indicates two cointegrating equations at the same significance level. Despite minor discrepancies between the two tests, each test exceeds the minimum requirement of at least one cointegration equation, thereby substantiating the presence of a long-term relationship among the time series. Consequently, it is concluded that a long-term relationship exists among the variables in the unemployment rate model.

Model Estimation

Table 4: Results of the Parsimonious Error Correction Unemployment Rate Model

	Dependent Variable = Natural log of Unemployment Rate			
Variables	Coefficient	Std.Error	t-Statistic	Prob.
C	0.056790	0.012655	4.487642	0.0004
DLOG(UEMP(-1))	0.283911	0.157350	1.804331	0.0913
DLOG(UEMP(-2))	0.178632	0.182121	0.980843	0.3422
DLOG(HEC)	0.113598	0.050275	2.259541	0.0392
DLOG(POC)	-0.080126	0.029951	-2.675290	0.0173
DLOG(POC(-1))	-0.045456	0.026850	-1.692935	0.1111
DLOG(POC(-2))	-0.136135	0.031562	-4.313266	0.0006
DLOG(NGC)	-0.434977	0.124863	-3.483627	0.0033
DLOG(NGC(-1))	-0.227700	0.142779	-1.594777	0.1316
DLOG(GEXP(-1))	-0.098448	0.035085	-2.805983	0.0133
DLOG(CPS(-1))	-0.094922	0.032295	-2.939183	0.0102
DLOG(TOPEN)	-0.089464	0.020428	-4.379439	0.0005
DLOG(TOPEN(-2))	0.033128	0.017801	1.860996	0.0825
DLOG(EXCR(-1))	0.050725	0.023375	2.170022	0.0465
ECM(-1)	-0.163294	0.071094	-2.296869	0.0364
R-squared = 0.788854	Adjusted R-squared = 0.591785		Prob (F-statistic) = 0.005769	
Note: ** and *** implies significance at 5%, and 10% levels of significant errors respectively **Source**: Author's computation, 2024				

Table 4 presents the findings from the estimated error correction model, which analyzes the impact of energy consumption on unemployment rate in Nigeria from 1990 to 2022. The focus is on the sign, magnitude, and statistical significance of the coefficients. A coefficient is considered statistically significant if half of its value exceeds the standard error, the t-statistic surpasses the critical value of 2.00, and the p-value is below 0.05.

Impact of Hydroelectricity Consumption on Unemployment Rate

The coefficients for hydroelectricity consumption at levels (0.113598) appears with a negative sign. Analyzing the standard error statistics (0.050275), t-statistics (2.259541), and probability values (0.0392), the study finds that levels hydroelectricity consumption significantly affect unemployment rate during the period 1990-2022. This indicates that hydroelectricity consumption significantly increased unemployment rate in Nigeria in the long run.

Impact of Petroleum Oil Consumption on Unemployment Rate

The coefficients of petroleum oil consumption at levels (-0.080126), one-period lag (-0.045456), and two-period lag (-0.136135) are negative. Considering the standard error statistics (0.029951, 0.026850, and 0.031562), t-statistics (2.675290, 1.692935, and 4.313266), and probability values (0.0173, 0.1111, and 0.0006), the study concludes that petroleum oil consumption at levels and two-period lag significantly influences unemployment rate from 1990 to 2022. This implies that petroleum oil consumption significantly reduces unemployment rate in Nigeria in both the long run and short run.

Impact of Natural Gas Consumption on Unemployment Rate

The coefficients of natural gas consumption at the level (-0.434977) and one-period lag (-0.227700) are negative. Based on the standard error statistics (0.124863 and 0.142779), t-statistics (3.483627 and 1.594777), and probability values (0.0033 and 0.1316), the study concludes that natural consumption at levels significantly impacted on unemployment rate from 1990 to 2022. This indicates that natural gas consumption reduces unemployment rate in the long run.

Impact of Selected Control Variables on Unemployment Rate

While government expenditure, credit to the private sector and trade openness significantly reduced unemployment rate, exchange rate significantly increased unemployment rate in the short run.

Error Correction Term [ECM(-1)]

The error correction term coefficient (-0.16) exhibits the theoretically expected negative sign. Given the standard error (0.071094), t-statistic (2.30), and p-value (0.0364), the statistical significance of the error correction term is evident. This indicates that the model corrects short-run disequilibrium and converges to long-run equilibrium at a rate of 16%.

Coefficient of Determination and Overall Significance of the Unemployment Rate Model

The concluding row in Table 4.4 displays the R-squared, Adjusted R-squared, and the likelihood of the F-statistics. An R-squared value of 0.7889 indicates that 78.89% of the variance in Nigeria's unemployment rate over the examined period is explained by the independent variables, underscoring the model's substantial explanatory capability. The Adjusted R-squared of 59.18 is very proximate to the R-squared value, indicating that augmenting the degrees of freedom by adding additional variables would probably provide a comparable association between the explanatory factors and the dependent variable. The p-value of the F-statistic (0.00) indicates that the overall unemployment rate model is statistically significant, signifying that all independent variables collectively have a statistically significant influence on the unemployment rate.

Post-estimation Diagnostic Tests

Table 5: Results of the Post-estimation Diagnostic Tests on the Unemployment Rate Model

Tests	F-Statistic	Prob>|F|	Decision
Breusch-Godfrey Serial Correlation LM Test	0.71	0.51	Null hypothesis of no serial correlation cannot be rejected.
Breusch-Pagan-Godfrey Heteroskedasticity	0.93	0.55	Null hypothesis of homoscedasticity cannot be rejected
Ramsey RESET Test	0.38	0.86	Null hypothesis of misspecification of model can rejected

Note: ** and *** implies significance at 5%, and 10% levels of significant errors respectively

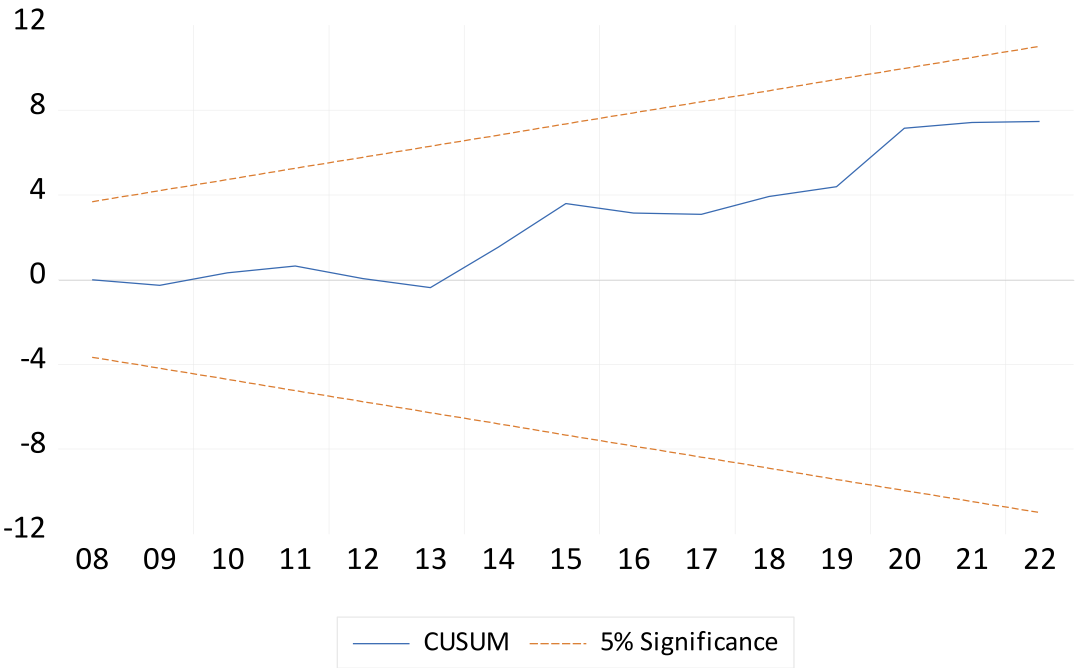
Source: Author's computation, 2024

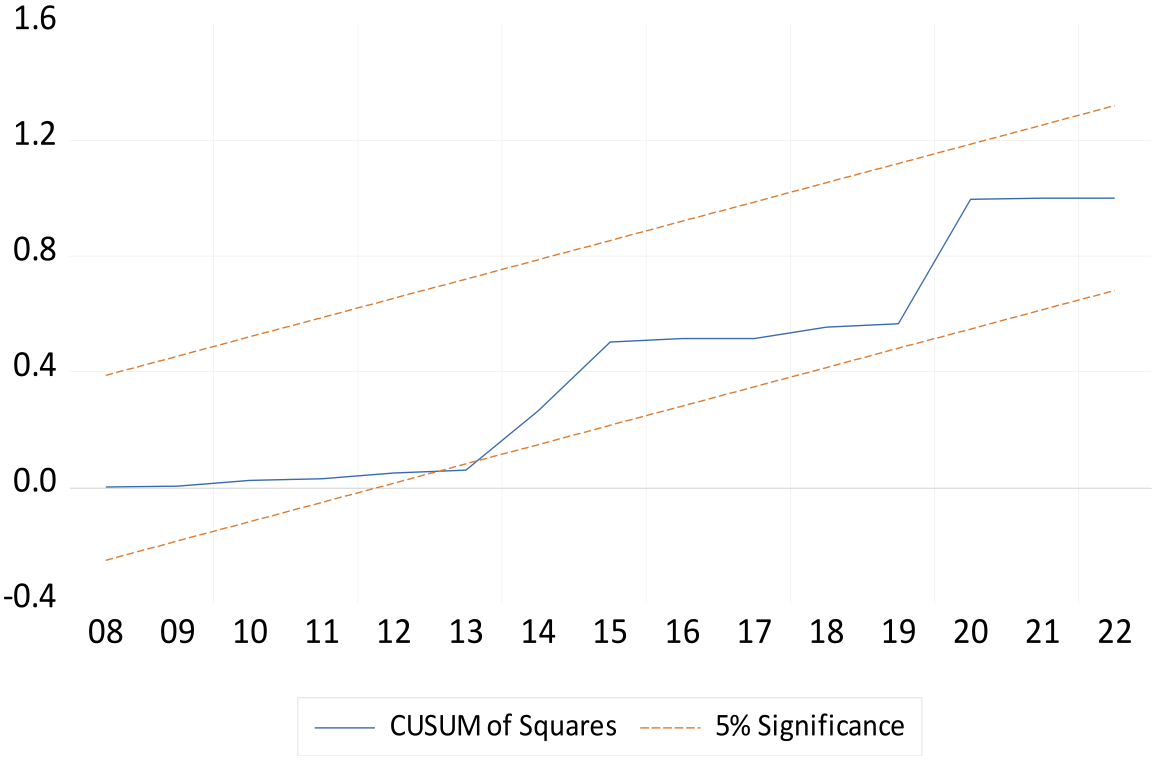
Serial Correlation Test: The result of the Breusch-Godfrey Serial Correlation LM test is presented in Table 5. The null hypothesis of no serial correlation in the parsimonious ECM model is tested at 0.05 level of significance. The p-value (i.e., 0.51) of the computed F-statistics (i.e., 0.71) reveals that the parsimonious error correction unemployment rate is free from serial autocorrelation problem.

Heteroscedasticity Test: The result of the Breusch-Pagan-Godfrey Heteroscedasticity test is presented in Table 5. The p-value (i.e., 0.55) of the computed F-statistics (i.e., 0.93) reveals that the parsimonious error correction unemployment rate model is free from the problem of heteroscedasticity.

Specification Test: The result of Ramsey Regression Specification Error Test (RESET) is presented in Table 5. The p-value (i.e., 0.86) of the computed F-statistics (i.e., 0.38) reveals that the parsimonious error correction unemployment rate model is well specified. The model is is free from misspecification error.

Stability Test: The CUSUM (Cumulative Sum) and This CUSUM of Squares plots presented below shows that plot stays within the critical bounds at 5% level. The unemployment rate model is therefore considered stable.





DISCUSSION OF FINDINGS

Notable conclusions have arisen from the data analysis about the impact of energy consumption on the unemployment rate as a measure of job creation. Consequently, analyzing the data subsequent to the literature study is a worthwhile pursuit. The research first examined the impact of renewable and non-renewable energy consumption on job generation, using the unemployment rate as a proxy. The research revealed that, whereas hydroelectricity consumption elevates the jobless rate in the long term, petroleum oil consumption markedly decreases the unemployment rate in both the short and long term. Moreover, the use of natural gas substantially decreases the unemployment rate over the long term. The discovery regarding the escalating impact of hydroelectric energy consumption on the unemployment rate aligns with the research conducted by Hillebrand et al. (2006), Rivers (2013), Zhao and Luo (2017), and Rafiq et al. (2018), which indicated that the consumption of renewable electricity has resulted in a rise in unemployment rates. Furthermore, the results on the detrimental effects of natural gas and petroleum oil consumption align with the research conducted by Khobai et al. (2020). The findings indicate that renewable energy usage adversely and significantly impacts unemployment in the long term. The research also revealed insights about the influence of control factors on the employment creation indicator. Government spending, loans to the private sector, and trade openness substantially decreased the unemployment rate, but the exchange rate markedly elevated the unemployment rate in the near term.

Concluding Remarks

The research determined that there is a disparity in the effect of renewable and non-renewable energy consumption on the unemployment rate in Nigeria. The use of renewable energy (hydroelectricity) has favorably impacted the unemployment rate in Nigeria, but the use of non-renewable energy (petroleum oil and natural gas) has significantly reduced unemeployment rate. In light of the study's conclusions and findings, the following suggestions are proposed: The Nigerian government should intensify efforts to enhance financing for research in energy development and energy infrastructure. Augment financial support for research and development to enhance the efficiency and cost-effectiveness of renewable energy systems. Invest in infrastructure that facilitates the incorporation of renewable energy into the grid, minimizing transmission losses and enhancing dependability. Secondly, the government should guarantee the availability of tax credits, subsidies, and grants to stimulate investments in renewable energy initiatives. This may aid in decreasing energy expenses and also mitigate unemployment rates. The government is advised to adopt initiatives that enhance energy efficiency in residential, commercial, and industrial sectors. This may decrease total energy usage and aid in decreasing unemployment.

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