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Real Growth Impact of Energy Use In Nigeria: An Empirical Analysis 2010-2024

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Abstract. *This study examined the empirical analysis of the growth impact of energy consumption in Nigeria. The information for the data was collected from the 2023 CBN statistical bulletin, Enerdata, and the WDI database, covering the period from 2010 to 2024. Economic growth served as the dependent variable, while electricity energy consumption, petroleum energy consumption, and natural gas energy consumption were the explanatory variables. The study reveals several key findings: there is an insignificant and Adverse relationship between electricity energy usage and Nigeria's economic development. In contrast, both petroleum and natural gas energy consumption show significant and positive relationships with economic growth. Furthermore, the analysis revealed a long-term connection between energy utilization and economic growth. In light of these results, the study suggests that the Nigerian government prioritize domestic refining and value chain integration by accelerating the rehabilitation of government-owned refineries. It also suggests providing targeted support, such as tax and import waivers for equipment, to private modular and large-scale refinery projects. A core priority is to reestablish the connection between energy used and economic output, ensuring that electricity becomes a reliable and productive factor of production. To achieve this, the government should implement urgent, ring-fenced targeted capital initiatives to reduce technical, commercial, and collection losses, particularly in the distribution segment. This will stabilize the grid, increase supply reliability, and ensure that generated power reaches end-users efficiently. Furthermore, the positive acceleration of the completion of essential domestic gas pipeline projects, including the Ajaokuta-Kaduna-Kano (AKK) pipeline. long-term effects of consuming natural gas for energy should be leveraged to drive sustainable industrial growth and fuel the power sector transition, particularly by expediting the completion of critical domestic gas pipeline projects, such as the Ajaokuta-Kaduna-Kano (AKK) pipeline, to guarantee a sufficient, dependable, and cost-effective gas supply to existing and planned power generation facilities. Further research is advised for updated policy recommendations*

Keywords: ARDL, Energy Consumption, Nigeria, Real Growth
JEL Codes: Q430; Q480

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Introduction

The relationship between economic growth and energy consumption is a crucial field of research, especially in developing nations such as Nigeria, which possess plentiful but

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underutilized energy resources. Nigeria is rich in various energy sources, including oil, natural gas and renewables, yet it encounters major obstacles in effectively utilizing these resources for economic advancement (Olayungbo & Olayiwola, 2024). Energy use plays a vital role in economic activities, driving industrial development, the expansion of infrastructure, and overall economic efficiency (Okonkwo, Adegboye & Nwanii 2023)

Historically, Nigeria's energy sector has faced challenges due to inefficient energy distribution, and a heavy reliance on fossil fuel (Aliyu & Isah, 2022), These hurdles not only hinder economic progress but also contribute to environmental degradation, complicating the relationship between energy consumption and economic performance (Eze & Okoro, 2021). The timeframe from 2010 to 2024 in particularly important for Nigeria, as it included a range of economic reforms, changes is policy, and fluctuations in the global energy market. During this time, variations in energy consumption driven by population growth, urbanization, and industrial development have been apparent. According to the World Bank (2023), Nigeria's per capita energy consumption remains relatively low compared to other countries in the region, highlighting the potential for economic advancement if energy resources are utilized more efficiently.

Some researchers contend that a rise in energy consumption is directly linked to an increase in GDP, indicating that energy plays a crucial role in driving economic activity(Umar Sani & Abubakar, 2023). A study by Eze & Okoro (2021) established a significant positive correlation between energy consumption and income generation, suggesting that improved access to electricity could boost economic activity, create wealth, and enhance living standards. On the other hand, several studies point to the adverse effects of energy consumption on a nation's economic status, especially regarding environmental sustainability. Olayungbo & Olayiwola (2024) argue that while increased energy usage may promote short-term economic growth, it also incurs substantial long-term environmental costs, which can lead to economic downturns due to issues related to health, climate change and resource exhaustion. This dual viewpoint underscores the necessity for adopting sustainable energy policies that reconcile economic progress with environmental conservation. In recent years, Nigeria has made efforts to diversify its energy sources, positioning renewable energy as a viable alternative to fossil fuels. To facilitate this transaction, the government has implemented strategies to enhance the proportion of renewable energy in the national energy mix, acknowledging that sustainable energy consumption can bolster income generation while reducing environmental

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repercussions (Aliyu & Isah, 2022). The Renewable Energy Master Plan(REMP), initiated in 2018, aims to substantially increase renewable energy capacity by 2030, thereby improving energy security and fostering sustainable development (Nigerian Federal Ministry of Power 2023)

Despite ongoing initiatives, there are still significant challenges to overcome. Ongoing inefficiency in the energy sector lead to regular power outages abs high energy costs, which negatively affect industrial productivity (Okonkwo et al, 2023) additionally, Nigeria's heavy reliance on oil exports makes the economy vulnerable to fluctuations in global prices, thus posing a threat to economic stability (Umar et al, 2023). Therefore, understanding the link between energy consumption and economic outcomes in essential for crafting effective policies that promote sustainable income generation in Nigeria. The country's economic trajectory is closely tied to its capacity to provide reliable and affordable energy. As a key player in Africa's economy, Nigeria has continually struggled with insufficient energy supply, hindering its prospects for sustained economic growth (Ayodele & Alayande). 2012). The ongoing energy supply deficit has extensive repercussions, impacting national productivity, the expansion of small enterprises, and overall economic performance (Sanusi, 2018). Over the years, Nigeria has encountered various economic challenges and opportunities, prompting the government to introduce several reforms within the energy and power sector, including privatization and investments in renewable energy, aimed at enhancing energy supply and distribution (NERC, 2023). However, the actual effects of these initiatives on the availability of energy and electricity remain a matter of discussion. This study will emphatically explore the connection between energy consumption and economic development in Nigeria, examining how variations in electricity and natural gas supply have influenced key economic indicators. The intricate relationship between energy usage and economic growth poses a significant challenge for Nigeria, a nation rich in energy resources yet hindered by ongoing inefficiencies in its energy sector. Despite its abundant oil reserves, natural gas and potential renewable energy options, Nigeria's inability to effectively utilize these resources undermines its economic advancement (Olayungbo & Olayiwola, 2024). The country's historically inadequate energy infrastructure, marked by inefficient distribution systems and a reliance on fossil fuels, hampers economic progress and worsens environmental degradation (Aliyu & Isah, 2022; Eze & Okoro, 2021). Notably, between 2010 and 2024, Nigeria saw variations in energy consumption, influenced by population growth, urbanization, and economic reforms, while per capital energy consumption

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remained low compared to regional counterparts (World Bank, 2023). Several studies indicate a positive correlation between energy consumption and economic growth, implying that energy is a key driver of economic activity(Umar Sani & Abubakar 2023). Other research underscores the negative long-term impacts of poor energy distribution on national income, particularly concerning environmental sustainability (Olayungbo & Olayiwola, 2024). Initiatives aimed at addressing these issues, such as the Renewable Energy master Plan(REMP) introduced in 2018, seek to enhance the energy mix by increasing the share of renewables by 2030 (Nigerian Federal Ministry of Power, 2023). However, ongoing inefficiencies, including high energy cost, frequent power interruptions, and limited energy access, continue to pose significant obstacles to industrial productivity and economic stability, particularly concerning environmental sustainability (Olayungbo & Olayiwola, 2024). Initiatives aimed at addressing these issues, such as the Renewable Energy Master Plan (REMP) introduced in 2018, seek to enhance the energy mix by increasing the share of renewables by 2030 (Nigerian Federal Ministry of Power, 2023). However, ongoing inefficiencies, including high energy costs, frequent power interruptions, and limited energy access, continue to pose significant obstacles to industrial productivity and economic stability (Okonkwo et al., 2023). Thus, there is a crucial need for a thorough empirical study to examine the complex relationship between energy consumption and economic growth in Nigeria. Current literature often overlooks the context-specific factors that shape this interaction within the country's distinct economic environment. Natural gas, abundant in Nigeria, offers a viable pathway to meet energy demand while generating lower emissions, resulting in numerous economic benefits. As the country shifts towards cleaner energy sources, prioritizing natural gas, known for its transitional role, is essential. Elements such as energy accessibility, technology progress, environmental considerations, and political dynamics are pivotal in shaping patterns of energy production and supply. Strategic investment and policies focused on harnessing natural gas can facilitate Nigeria's energy transition, effectively balancing environmental commitments with economic objectives (Remteng, 2022)

The primary objective of this research is to empirically examine the relationship between energy consumption and economic growth in Nigeria from 2010 to 2024. Analysing how fluctuations in energy supply affect vital economic indicators. This research is significant as it can provide insights for policy-making aimed at improving sustainable energy consumption, which in turn supports economic growth while addressing the environmental issues linked to energy usage. Generally, an increase in energy demand corresponds with a rise in gpd growth, and various studies suggest a

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positive correlation between electicity consumption ans economic growth(Umar Sani & Abubakar, 2023: Eze & Okoro, 2021). However, there are worries regarding the environmental consequences of energy consumption, which may undermine long-term economic stability (Olayungbo & Olayiwola, 2024). Recent government efforts focus on diversifying energy sources and encouraging renewable energy through the renewable energy master energy sources and encouraging renewable energy through the renewable energy master plan(Nigeria federal ministry of Power, 2025), yet challenges like high energy prices and dependence on oil exports continue to impede economic stability (Okonkwo et al, 2023; Umar et al 2023). Therefore, it is crucial to understand how energy consumption interacts with economic growth to create policies that promote sustainable economic development in Nigeria, particularly in contexts where ongoing declines in energy supply negatively impact industrial productivity and overall economic Output (Ayodele & Alayande, 2012; Sanusi, 2018). This study intends to empirically assess how variations in energy supply affect essential economic indicators in Nigeria.

In recent years, the relationship between economic growth and energy consumption has attracted significant interest from researchers and policymakers alike. The growth-led energy hypothesis (GLEH) is a crucial concept that posits economic growth leads to an increase in energy demand. By applying GLED in this research, we can gain better insights into how economic fluctuations influence energy requirements and how the availability of energy impacts growth (Eze & Okoro 2021).. The significance of GLEH highlights the interplay between economic expansion and energy use, emphasizing how growth drives energy demand. The hypothesis offers valuable perspectives, particularly for developing nations like Nigeria, where energy infrastructure plays a vital role in facilitating economic activities. Incorporating GLEH into the study can assist policymakers in diversifying energy sources and enhancing energy efficiency, ultimately promoting economic growth while addressing environmental issues. Additionally, GLEH reinforces the necessity of dependable energy access, which is fundamental for improving living standards and boosting productivity (Gwenhure & Odhiambo, 2015).

Expanding upon traditional economic theories, it is crucial to delve into the insights offered by endogenous growth theory. This perspective highlights the significance of investing in human capital and innovation as vital components driving productivity and economic growth. Acknowledging this viewpoint emphasizes the role that advancements in energy utilization and technology can play in promoting sustainable economic development within the country. A core

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tenet of endogenous growth theory is the idea that investment in human capital and research spurs economic expansion(Romer, 1990). The endogenous growth theory asserts that economic growth is mainly influenced by internal factors rather than external ones. This theory focuses on the importance of knowledge, innovation, and human capital in facilitating economic development. In the context of Nigeria, where energy consumption and technological progress are critical, applying endogenous growth theory can shed light on how innovations in energy usage can drive economic growth.

Considering potential unintended consequences, the rebound effect theory indicates that improvements in energy efficiency can result in increased overall energy consumption rather than a reduction. This phenomenon occurs because greater efficiency reduces the cost associated with energy use, leading to higher consumption levels. In Nigeria, researchers have examined this theory in various sectors. Endogenous growth theory suggests that economic growth is driven by internal factors within the economy, such as technological progress and human capital, instead of external factors. in the context of energy consumption in developing nations like Nigeria, this theory implies that optimising energy use can boost productivity and stimulate innovation (Galadima & Aminu, 2019). Reliable energy access fosters industrial development and supports research and development initiatives. Investing in renewable energy sources, along with enhancing education and skills, can lead to more efficient energy usage and sustainable solutions. For Nigeria, adopting these strategies could enhance economic competitiveness, reduce reliance on fossil fuels, and address environmental challenges. Ultimately, incorporating endogenous growth theory into energy policy supports the development of a sustainable and thriving economy (Gershon & Ezurum, 2017).

The emphasis on internal factors as catalysts for economic growth signifies a transition from conventional economic theories focused on capital and labor. Non- classical growth theory underscores the essential role of energy in production, influencing revenue across various sectors including manufacturing, agriculture, and services (Ojo, 2021). In Nigeria, the energy sector encounters obstacles such as insufficient infrastructure and unreliable supply, yet the promise of renewable energy could improve production, particularly for SMEs (Adebayo.2022). Consistent energy access fosters innovation, enhances operational efficiency and drives economic growth (Iwuchukwu, 2023), also playing a vital role in attracting foreign direct investment (Adeyemi, 2020). Energy plays a significant role in agriculture by enabling irrigation and food processing,

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thereby bolstering food security and economic stability(Nwachukwu, 2022). The Nigerian government is implementing policies aimed at improving energy access abs promoting renewable sources, aiding in job creation and sustainable development (Okeke, 2023). The energy-led growth hypothesis suggests that an increase in energy consumption directly enhances economic income and productivity(Umar Sani &Abubakar, 2023). While there is a positive link between energy access, specifically electricity and natural gas, and economic growth (Eze & Okoro, 2021), some critics caution that this could result in long-term environmental challenges (Olayungbo & Olayiwola, 2024). The energy-growth Nexus theory provides a significant framework for exploring the relationship between energy consumption and economic growth within Nigeria, offering critical insights for policymakers and energy sector stakeholders. Serving as the theoretical basis, this perspective facilitates the analysis of the interaction between energy use and economic performance in the Nigerian context. Its strong empirical grounding, direct relevance to Nigeria's specific situation, and ability to guide policy decisions highlight its importance. The theory effectively addresses the complexities surrounding Nigeria's energy resources and their potential to drive sustainable economic growth through income generation, thereby offering valuable insight for stakeholders and policymakers in the energy field.

2. Literature Review

The structure of this investigation is organized as follows: Apart from section 1 that contains the introduction, Section 2 presents the empirical review, Section 3 outlines the research methodology, Section 4 discusses the empirical findings, and Section 5 provides the concluding remarks.

Research on the interplay between energy consumption and economic growth in Nigeria presents a nuanced picture revealing both positive and negative dynamics. Numerous studies indicate a notable positive correlation, suggesting that rising energy consumption can spout economic development; however, the complexity associated with this relationship must also be recognized. For example, Eze and Okoro (2021) discovered that improved access to electricity enhances economic activities and elevates the standard of living. In addition, Umar Sani and Abubakar (2023) assert that increased energy consumption is linked to growth in GDP, highlighting the essential role of energy in fostering economic initiatives. On the other hand, some scholars warn of the long-term detrimental effects of energy consumption on economic growth, particularly regarding environmental sustainability. Olayungbo and Olayiwola(2024) argue that while energy consumption may yield short-term economic advantages, its negative environmental effects, such as health

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issues, climate change and resource depletion, could ultimately impede economic development. The energy sector in Nigeria has traditionally faced challenges related to insufficient infrastructure and inefficiency, as noted by Aliyu and Isah (2022) and Okonkwo, Adegboye, and Nwaniji(2023). These inefficiencies contribute to recurring power outages and elevated energy costs, thereby constraining industrial productivity and economic stability. Efforts are underway to diversify the renewable Energy master plan (REMP) which aims to bolster energy security by increasing the capacity for renewable energy by 2030 (Nigeria's federal Ministry of Power 2023). A study examining the influence of gad utilization on Nigeria's economic growth from 1999 to 2021 found a strong positive relationship between GPD and both the domestic gas market(DGM) and the export gas market (EGM). Specifically, the regression analysis indicated that growth in these markets positively contributes to GDP, underscoring the necessity for strategic investments in gas infrastructure(Ngwu & Ofoegbu, 20204). Similarly, Galadima and Aminu (2019) emphasize the significant role of natural gas in promoting long-term economic growth in Nigeria, with its benefits outweighing any adverse effects. They stress the importance of enhancing domestic consumption and adopting energy-efficient technologies to achieve sustainable growth while mitigating environmental challenges. Nonetheless, dependence on oil exports and vulnerability to fluctuations in global oil prices remain threats to economic stability (Umar et al, 2023)

In summary, the literature underscores the essential need for a comprehensive approach. Balanced approach to energy consumption fosters economic growth while addressing environmental concerns. According to Gbadelo & Okonkwo (2009), Rising energy consumption constitutes a critical determinant of economic growth, particularly given the energy sector's potential to expand supply capacity. Oseni (2012) observes that over 40% of Nigerian households remain without access to energy, underscoring the urgency of addressing supply constraints. Furthermore, no nation can progress and maintain development beyond basic survival without at least a minimum level of access to energy services for a substantial part of its population. Digitized machinery and infrastructures in every economy run with energy consumption, little wonder. Gershon & Ezurum (2017). It was highlighted that the governance and pricing effectiveness in Nigeria's energy sector impact power tools and energy policies across West Africa. This variation in the cost of providing a unit of electric energy by region plays a crucial role in determining economic growth. Many scholars concur that there is a correlation between access to modern energy sources and economic development, but there is a limitation in linking the

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interconnectedness. The government makes policies around unmet energy demands to increase supply according to the increasing volume of demand. Indicators to the above conclusion are basically on improvement of energy supply, skills for energy generation, access to finance and roads, and access to the market.

Variations in user types and energy consumption determine revenue capacity, showing the need for an economic distribution model with a dynamic and flexible structure to allow different configurations and operating conditions for the used algorithm to accommodate third-party producers, prosumers, and high-energy consumers, as well as solidarity-based objectives, addressing energy poverty and promoting sustainable economic growth through energy consumption. (Marrasso, Martone, Perugini & Roselli (2025)

Although the study establishes a long-run relationship between energy consumption and economic growth, it offers limited exploration of the long-term implications for economic sustainability and environmental outcomes. Future research could examine how sustainable energy practices might be integrated without constraining economic progress. Moreover, while the study focuses on Nigeria at the national level, it overlooks regional disparities in energy consumption and growth. A deeper understanding of these regional variations could yield more targeted and effective policy recommendations.

3. Methodology

The nature of the data sets used for this research is secondary data because they were obtained from another study and not produced or created in the course of this work. The data are also quantitative because they can be measured, and a number is attached to every data point showing its relevance. Also, they are time series in nature because it is time bound and each datum is for a particular and specific time. This is all because obtaining a primary data set, which some researchers argue is the best in a research work, given the nature of the research being empirical and quantitative, is impossible. The necessary data for this study covers a time span of 2010 to 2024. The Central Bank of Nigeria (CBN) is Nigeria's major routine compiler and source of statistical data. Also, Energy Data, the National Bureau of Statistics (NBS), and the World Bank bulletins were chosen as the source of data for the Energy Consumption because they are the most accepted repositories of data

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worldwide. The study adopted in consistent with the methodology employed by Eneoli, Kalu, Ukpere, & Monyei (2025).

This research employs five variables, comprising one dependent and three independent factors. The dependent variable, economic growth, captures the increase in the production of goods and services within an economy over a defined period. The independent variables include Electricity Energy Consumption (EEC), Petroleum Energy Consumption (PEC), and Natural Gas Energy Consumption (NGEC). These dimensions of energy use are particularly relevant to this study, as they represent critical avenues through which stable economic growth can be fostered in Nigeria. Electricity energy consumption was included based on the Energy-Led Growth theory, which suggests energy consumption drives economic growth. Orungbe, Nwogwugwu, & Okeyika (2024) provide empirical evidence on the relationship between energy consumption and economic growth in Nigeria. The study reveals a significant positive correlation between electricity consumption and economic growth. In contrast, natural gas consumption was found to exert a statistically insignificant negative effect on economic growth, suggesting that electricity use plays a more substantial role in driving economic expansion. The expected impact is that increased electricity consumption is likely to boost economic growth. Also, the Petroleum energy consumption was selected based on neoclassical theory, which emphasizes the role of energy in production. Empirical evidence shows that petroleum consumption significantly impacts economic growth in Nigeria, a major oil-producing country. The expected impact will likely contribute positively to economic growth. In this research, Interest Rate and Exchange Rate were utilized as control variables. Control variables are those that are kept constant or taken into account in an experiment or statistical analysis to assess the relationship between the independent and dependent variables. In their study, Arize, Kalu, and Nkwor (2018) employed the Autoregressive Distributed Lag (ARDL) Model in their research published in International Business and Finance. The dependent variable's role in the explanation of the independent variable. The functional notation of the model, as indicated below, then shows the relationship and impact of Electricity Energy Consumption (EEC), Petroleum Energy Consumption (PEC), Natural Gas Energy Consumption (NGEC) to Economic growth (GDP) in the model below.

This functional relationship can now be written in an Auto-Regression Model Equation to help evaluate the effect of the dependent variables on the independent variable. The general Equation involving all variables can then be written as:

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$$GDP_t = \beta_0 \sum_{n=1}^{k} \Delta\beta_1 GDP_{t-n} + \sum_{n=1}^{k} \Delta\beta_2 EEC_{1_{t-n}} + \sum_{n=1}^{k} \Delta\beta_3 PEC_{2_{t-n}} + \sum_{n=1}^{k} \Delta\beta_4 NGEC_{3_{t-n}} + \sum_{n=1}^{k} \Delta\beta_5 MPR_{4_{t-n}} + \sum_{n=1}^{k} \Delta\beta_6 EXR_{5_{t-n}} + p1^{EEC_t} + p2^{PEC_t} + p3^{NGEC_t} + p4^{MPR_t} + p5^{EXR_t} + E_t$$

Where:

β_o = Constant of the dependent variable when the independent is held at zero (0)

$\beta_1 - \beta_4$ = Coefficient of the short run parameter

$\rho_1 - \rho_4$ = Coefficient of the long run parameters

GDP Economic Growth

EEC Electricity Energy Consumption

PEC Petroleum Energy Consumption

NGEC Natural Gas Energy Consumption

MPR Monetary Policy Rate

EXR Exchange Rate

ε_t = Error or Stochastic term

Δ = Difference operator

The initial stage of the analysis involves computing basic descriptive statistics, which summarize the dataset and highlight key measures such as central tendency, dispersion, skewness, and kurtosis. This step facilitates an understanding of the distributional properties of the variables and assists in detecting potential issues before estimation. By examining these statistics, valuable insights can be gained regarding central tendencies, variability, distributional patterns, and the presence of outliers within the data. Additionally, graphs and charts will be employed to visually represent the data for clearer understanding. Correlation analysis will also be performed to evaluate the strength and direction of the linear relationship between two variables. Specifically, Pearson's correlation coefficient, denoted as "r," will be utilized to measure the linear association between two continuous variables, ranging from -1 to +1. A unit root test will be carried out to assess the stationarity of the variables involved. The concept of a unit root refers to a stochastic process where

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a variable exhibits non-stationary behaviour. This test is essential for determining the order of integration for each variable, and the research will implement the Augmented Dickey-Fuller (ADF) test.

This study adopts the Autoregressive Distributed Lag (ARDL) approach, an econometric technique well-suited for estimating both long-run and short-run relationships among variables within a time series framework. The ARDL method was preferred over Ordinary Least Squares (OLS) due to its distinct advantages: it allows the inclusion of variables with different orders of integration within the same model, accommodating cases where some variables are stationary (I(0)) while others are non-stationary (I(1)). In contrast, OLS assumes all variables are stationary, which can yield misleading results when applied to non-stationary data. Furthermore, ARDL captures both long-run and short-run dynamics, whereas OLS primarily emphasizes contemporaneous relationships.

Following estimation, significance tests were conducted to determine whether the estimated coefficients in the model differ meaningfully from zero, thereby indicating valid relationships among the variables. In addition, an autocorrelation test was performed to evaluate potential dependence among the residuals of the model. This involved examining the relationship between errors at time t and those at time $t-1$ using the Breusch-Godfrey Lagrange Multiplier (BG LM) test.

A heteroscedasticity test was subsequently conducted to assess whether the variance of residuals remains constant across different levels of the independent variables. Heteroscedasticity arises when residual variability is non-uniform and systematically fluctuates, making its detection and correction essential. This analysis was carried out using the Breusch-Pagan-Godfrey (BPG) test.

A model stability test was conducted to evaluate whether the relationships between the variables remain consistent over time or across various subsets of the data. Ensuring the reliability and applicability of the estimated model beyond the specific timeframe or data subset is essential. The stability testing will utilize the **Ramsey RESET and CUSUM tests**. This analysis is a crucial statistical procedure for making inferences and drawing conclusions about population parameters based on sample data. EViews 10 software will be utilized for developing and executing the analytical processes necessary for making informed statistical decisions. Decisions in this study will be based on a 5% significance level, guiding the conclusions drawn from the analysis.

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4. Results

To depict the behavioral pattern of the variables, the series were plotted in a line and symbol multiple graphs.

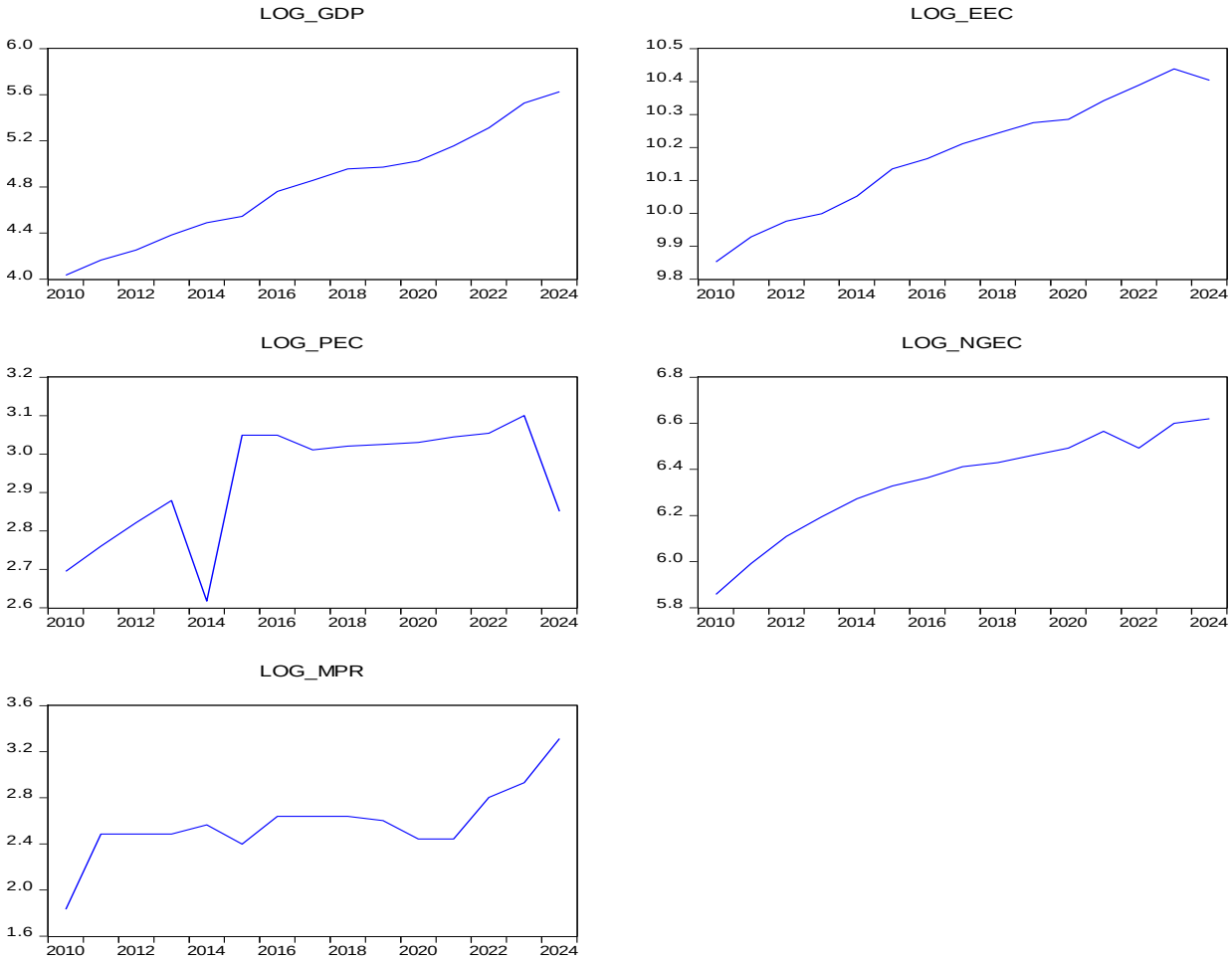

Fig 1 Line Graph of the Variables of Interest

Source: Graphed by the author using Eviews

The Nigerian economy (LogGDP) shows a strong, consistent upward trend throughout the entire period, suggesting overall positive economic expansion. The growth rate appears to have slowed slightly around the 2014-2017 period (likely reflecting the 2016 economic recession) before accelerating noticeably in the years following 2020. LogEEC (Electricity Consumption) has a smooth, steady upward trend closely matching LogGDP growth, indicating a strong, stable positive link with Nigeria's economic growth.

LogNGEC (Natural Gas Consumption) shows a positive upward trend with LogGDP, but

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with some volatility, including a dip in 2021/2022 and a quick recovery. LogPEC (Petroleum Consumption) is the most volatile, with a drop in 2014, stability 2015-2022, a spike in 2023, and a steep 2024 decline (despite rising LogGDP), likely due to policy changes like fuel subsidy removal. A bar chart with a regression line was used to show the correlation between these variables and LogGDP

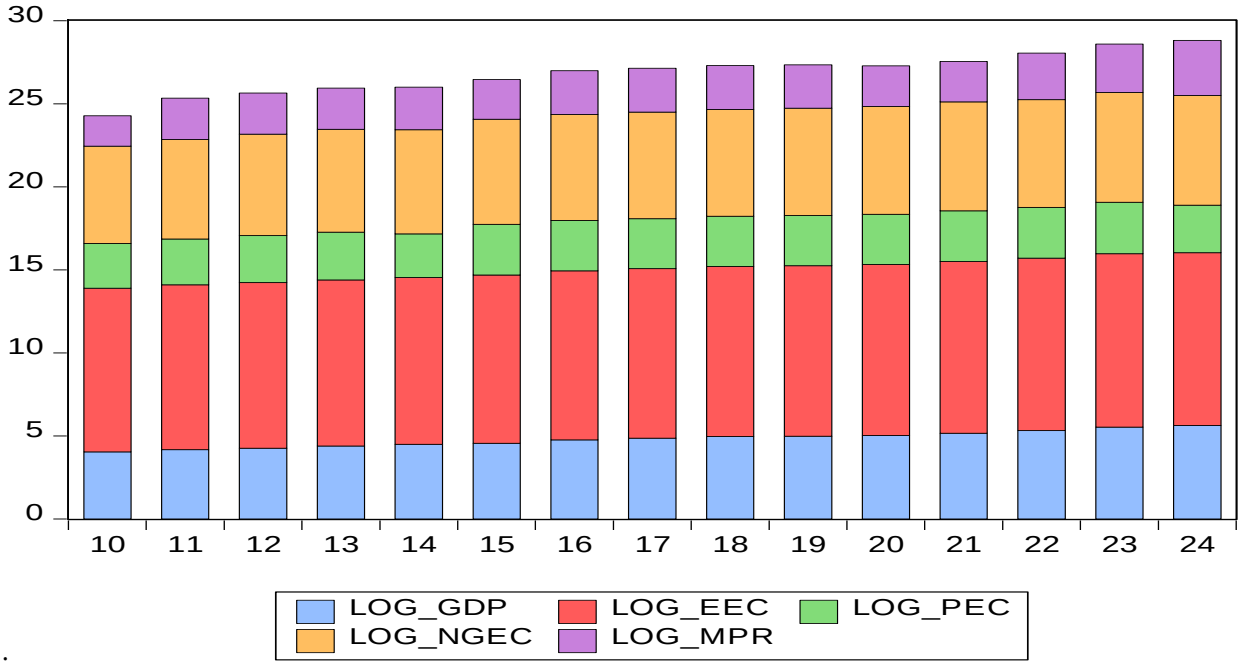

Fig 2. A Bar Plot of the Variables of Interest

Source: Graphed by the author using Eviews

Log_EEC (Electricity Consumption) exhibits a remarkably consistent and linear upward trajectory with Log_GDP, climbing from 9.8 in 2010 to 10.4 in 2023, reinforcing electricity's role as a fundamental driver of Nigeria's economic expansion. Log_NGEC (Natural Gas Consumption): also shows a steady positive trend (5.8 to 6.6), indicating growing gas utilization aligned with economic growth, though interrupted by a 2021/2022 dip and sharp 2024 rebound, hinting at supply or utilization fluctuations. and Log_PEC (Petroleum Consumption) Displays pronounced volatility, with movements seemingly detached from Log_GDP. A sharp 2023 peak precedes a dramatic 2024 collapse, likely reflecting the subsidy removal's impact on prices and consumption. Notably, economic growth persisted despite this decline.

Log_PEC (Petroleum Consumption) indicates a potential shift in dependency patterns or a lagged response, deviating from its usual trend. While Log_MPR (Monetary Policy Rate) remained steady between 2.2 and 2.6 (2010 - 2021), signaling consistent interest rate policy. Then, it surged

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sharply to an all-time high peak, marking a significant policy shift. This represents the Central Bank's aggressive tightening of the policy rate to curb runaway inflation.

Descriptive statistics were calculated to assess the overall trends within the series, evaluate deviations from their average values, and examine the symmetrical characteristics of the series. Below is a summary table of the Basic Descriptive Statistics for the level series of both the dependent and independent variables.

The Jarque-Bera test determines if the data is normally distributed. Since the Probability values for all variables are greater than 0.05 (e.g., 0.7198 for LogGDP and 0.3227 for Log_MPR, the null hypothesis of normal distribution cannot be rejected at the 5\% significance level for any of the variables. LOGMPR has the highest Kurtosis (4.9004), indicating a distribution with fatter tails and a sharper peak than a normal distribution, driven by the extreme values observed in the latter years. LOGGDP and LOGEEC have Kurtosis values below 3 (1.9853 and 1.8814, respectively), meaning they are platykurtic (flatter tails than a normal distribution). The Electricity Energy Consumption (LogEEC) and Gas (LOGNGEC) series show the lowest volatility (RSD 1.81\% and 3.53\%) and clear long-term trends in the graph, suggesting they are the most stable drivers in the system.

Table 1: Basic Descriptive Statistics

	LOGGDP	LOGEEC	LOGPEC	LOGNGEC	LOGMPR
Mean	4.804188	10.17970	2.933797	6.345972	2.580229
Median	4.856162	10.21097	3.020425	6.411818	2.564949
Maximum	5.625785	10.43822	3.100092	6.620073	3.314186
Minimum	4.033887	9.852194	2.617396	5.857933	1.832581
Std. Dev.	0.488087	0.184392	0.151688	0.224243	0.313993
Skewness	0.075431	-0.274201	-0.830936	-0.798337	0.044216
Kurtosis	1.985328	1.881415	2.334464	2.708716	4.900399
Jarque-Bera	0.657699	0.969985	2.002973	1.646385	2.262085
Probability	0.719751	0.615702	0.367333	0.439028	0.322697
Sum	72.06281	152.6955	44.00695	95.18959	38.70344
Sum Sq. Dev.	3.335200	0.476006	0.322128	0.703990	1.380281
RSD	0.10	0.01	0.05	0.03	0.12

Source: Computed by the author Using Eviews

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Monetary Policy Rate (LogMPR) is the most volatile series (RSD 12.17%), indicating the aggressive and fluctuating nature of monetary policy during the sampled period, especially after 2021. Given the presence of strong trends (high RSD for Log GDP and Log MPR and the likelihood that all variables are not stationary, this project work will appropriately require advanced time series modelling techniques, such as the Autoregressive Distributed Lag (ARDL) model was employed to test for co-integration and causal relationships among the variables. To further examine the linear associations, correlation matrices were computed, providing insights into the strength and direction of the relationships.

Table 2: Correlational Matrix

Correlation t-Statistic Probability	**LOG_GDP**	**LOG_EEC**	**LOG_PEC**	**LOG_NGEC**	**LOG_MPR**
LOG_GDP	1.000000				

LOG_EEC	0.984021	1.000000			
	19.92608	-----			
	0.0000	-----			
LOG_PEC	0.628075	0.722026	1.000000		
	2.910169	3.762721	-----		
	0.0122	0.0024	-----		
LOG_NGEC	0.947686	0.970516	0.702458	1.000000	
	10.70454	14.51740	3.558603	-----	
	0.0000	0.0000	0.0035	-----	
LOG_MPR	0.785841	0.725361	0.313727	0.735490	1.000000
	4.581596	3.799309	1.191304	3.913964	-----
	0.0005	0.0022	0.2548	0.0018	-----

Source: Computed by the author using Eviews

The primary focus is on the relationship between the dependent variable LogGDP and all explanatory variables, which exhibit a positive and statistically significant correlation with LogGDP. All three energy consumption types are statistically and positively correlated with LogGDP, with LogEEC and LogNGEC having the most dominant relationship. Multicollinearity exists when independent variables are highly correlated with each other, which can make it difficult to estimate the unique impact of each variable in a regression model. A correlation coefficient above 0.80 is often considered problematic. For LogEEC and LogNGEC , This is an extremely high

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positive correlation, indicating that electricity consumption and gas consumption move almost perfectly together. This high co-movement poses a serious multicollinearity threat for any model including both variables simultaneously.

Table 3: Traditional Unit Root Test

VARIABLES	TRADITIONAL UNIT ROOT TEST			
	ADF	TVC @ 5%	P. VALUE	DECISION
Log_GDP	-12.59	-4.25	0.0001	I (1)
Log_EEC	-5.16	-3.67	0.0030	I (1)
Log_PEC	-4.26	-3.71	0.0188	I (0)
Log_NGEC	-7.20	-3.67	0.0001	I (1)
Log_MPR	-6.25	-3.66	0.0003	I (1)

Source: Computed by the author using Eviews

A stationarity test was performed to assess the stationarity characteristics of the variables being analysed, in order to prevent the possibility of conducting an inaccurate regression. The test employed was the Augmented Dickey-Fuller (ADF), which aligns with the Traditional Unit Root Test and Breakpoint Unit Root Test. Conclusions were drawn based on a significance level of 5%. Below is the table presenting the results of both the Traditional Unit Root Test and the Breakpoint Unit Root Test.

Table 4: Breakpoint Unit Root Test

VARIA-BLES	INNOVATIVE OUTLIER					ADDITIVE OUTLIER				
	ADF	TCV @ 5%	P.V	Decision	Break Date	ADF	TCV @ 5%	P.V	Decision	Break Date
Log_GDP	-10.48	-4.44	0.01	I (0)	2018	-10.77	-4.44	0.01	I (1)	2015
Log_EEC	-7.19	-5.16	0.01	I (0)	2011	-8.53	-5.16	0.01	I (0)	2019
Log_PEC	-6.04	-4.44	0.01	I (0)	2016	-5.25	-4.44	0.01	I (0)	2015
Log_NGEC	-9.51	-4.44	0.01	I (1)	2019	-8.53	-4.44	0.01	I (1)	2020
Log_MPR	-10.08	-4.44	0.01	I (1)	2011	-9.43	-4.44	0.01	I (1)	2011

Source: Computed by the author using Eview

LogPEC is the only variable that is stationary at its level I (0)). The ADF statistic (-4.26) is greater than the 5% Critical Value (-3.71), and the p-value (0.0188) is less than 0.05. This means LogPEC can be directly included in any short-run model (like an ARDL short-run equation) without being differenced. The extreme volatility shown in the graph is reflected in its I (0) status, as shocks to this series are temporary and do not permanently affect its mean.

Log_GDP , Log_EEC , Log_NGEC , and Log_MPR are non-stationary at their level (Unit

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Root present) and are therefore integrated of order one, I (1). For all these variables, the absolute ADF statistics (e.g., 12.59| for Log_GDP) are greater than their respective Critical Values, and their P. VALUE is 0.0001 or 0.0030, which strongly rejects the null hypothesis of non-stationarity.

Table 5: ARDL Regression Result and Diagnostics Test (MODEL 2, 0, 0, 0, 0)			
PANEL A: SHORT RUN ESTIMATES			
VARIABLES	MODEL (2, 0, 0, 0, 0)		
	CO FFICIENT	T-STAT	P-VALUE
Log_EEC	1.65	2.90	0.0275
Log_PEC	-0.07	-0.48	0.0461
Log_NGEC	0.33	0.88	0.4135
Log_MPR	0.41	3.77	0.0093
PANEL B: LONG RUN ESTIMATES			
VARIABLES	MODEL (2, 0, 0, 0, 0)		
	CO EFFICIENT	T-STAT	P-VALUE
Log_EEC	-1.07	-0.76	0.4653
Log_PEC	2.10	0.80	0.0085
Log_NGEC	0.85	0.25	0.0251
Log_MPR	1.96	1.09	0.3028
PANEL C: DESCRIPTIVE STATISTICS			
STAT	MODEL (2, 0, 0, 0, 0)		
R2	0.99		
DW STAT	1.95		
F-STAT	239.32 (0.0001)		
BG-LM2	5.57 (0.0977)		
BPG	0.69 (0.6472)		
RESET1	1.68(0.13)		
CUSUM	STABLE		
CUSUM OF SQUARE	STABLE		

Source: Computed by the author using Eviews

The descriptive statistics result in panel c of Table 4.7, specifically, the R2 of the model shows a good test of fit. The R^2 of 0.99 is extremely high, indicating that 99% of the variation in the dependent variable is explained by the independent variables (LogEEC, LogPEC, LogNGEC, and LogMPR). The F-statistic of 239.32 with a P-value of 0.0001 (which is < 0.05) signifies that the model is highly statistically significant overall. The independent variables, as a group, are strong predictors of the dependent variable.

The Durbin-Watson (DW) statistic of 1.95, being close to 2, suggests the absence of

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significant first-order autocorrelation. This is further supported by the Breusch-Godfrey (BG-LM2) test, which produced a p-value of 0.0977 (greater than the 0.05 threshold), leading to a failure to reject the null hypothesis of no serial correlation. Similarly, the Breusch-Pagan-Godfrey (BPG) test yielded a p-value of 0.6472 (> 0.05), indicating that the model does not suffer from heteroscedasticity. The Ramsey RESET1 test, with a p-value of 0.13 (> 0.05), confirms that the model is correctly specified and free from functional form misspecification. Importantly, both the CUSUM and CUSUM of Squares tests report stability, signifying that the estimated coefficients remain consistent throughout the sample period and can be reliably applied in analysis.

In terms of results, petroleum energy consumption demonstrates a negative short-run effect on Nigeria's economic growth, with a coefficient of -0.07 and a statistically significant p-value of 0.0461. This adverse impact is largely attributable to the country's extensive petroleum subsidies, which, when consumption rises, inflate government expenditure and divert critical public funds away from sectors such as education, healthcare, and infrastructure—areas that could generate immediate economic returns. Consequently, this resource diversion hampers short-term growth, outweighing potential benefits from increased energy use.

Conversely, the long-run effect of petroleum energy consumption on economic growth is both highly positive and statistically significant, underscoring its importance in sustaining economic expansion over time. Petroleum energy is a foundational element for Nigeria's sustained economic expansion, powering key sectors like manufacturing, transportation, and large-scale infrastructure projects that drive GDP gains (Olowe, 2021). For a developing economy like Nigeria, a stable and increasing supply of energy is crucial for achieving higher levels of industrialization and technological adoption, which are the main engines of sustained economic growth. As the economy grows and diversifies, the reliance on petroleum energy may evolve, but its role in laying the groundwork for long-term prosperity cannot be overstated.

The analysis shows that LogNGEC (Natural Gas Consumption) has a positive coefficient of 0.33, implying that a 1% increase in natural gas consumption could lead to a 0.33% increase in economic growth. However, the P-value of 0.4138 is significantly higher than the 0.05 threshold, rendering the observed positive effect statistically unreliable. This suggests that in the short run, the influence of natural gas usage on economic growth isn't conclusive.

In the long run, though, natural gas plays a vital role in driving Nigeria's sustainable economic growth (Aniefiok, 2022). As the primary fuel for power plants, a stable gas supply

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translates to stable electricity, which is crucial for manufacturing, services, and overall productivity. This, in turn, fuels economic expansion. Additionally, gas is a key input for industries like petrochemicals, fertilizers, and other heavy sectors, supporting the growth of Nigeria's non-oil industrial base.

Moreover, natural gas is a less carbon-intensive fuel compared to petroleum, making it an environmentally friendlier option. Transitioning to gas can facilitate more sustainable long-term growth, minimize environmental costs, and potentially attract green investments. Overall, while the short-term impact is uncertain, natural gas is a critical component of Nigeria's long-term economic strategy, supporting energy stability, industrial growth, and sustainable development.

5. Conclusion

The long-run results from the energy consumption analysis reveal a critical and complex dichotomy within the Nigerian economy. Economic growth is strongly driven by primary fossil fuels but severely hampered by the inability to convert these fuels into reliable, usable electricity.

These findings confirm that while energy consumption is a foundational necessity for economic expansion, the structural composition and reliability of Nigeria's energy system dictate its overall impact. The findings also describe an economy that is highly dependent on raw, primary resource extraction and utilization (Petroleum and Natural Gas) for its long-term growth, while simultaneously being crippled by the failure of its infrastructure (the Electricity grid) to convert that raw energy into a usable, stable public good.

For Nigeria to transition to a more stable and sustainable growth path, the policy priority must shift from focusing solely on the source of energy to ensuring the efficiency and stability of its distribution. The high positive coefficients for fossil fuels indicate where the economy is; the negative coefficient for electricity indicates where the economy should be.

The core priority is to restore the link between energy consumed and economic output, making electricity a reliable and productive factor of production. Therefore, the government should Implement measures that will stabilize the grid, increase supply reliability, and ensure that generated power reaches end-users efficiently.

Government should prioritize domestic refining and value chain Integration by accelerating the rehabilitation of government-owned refineries and provide targeted support (tax and import

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waivers for equipment) to private modular and large-scale refinery projects. Introduce a Domestic Crude Supply Obligation (DCSO) to ensure feedstock for local refineries.

The positive long-run impact of NGEC should be leveraged to drive sustainable industrial growth and fuel the power sector transition by furthering the completion of critical domestic gas pipeline projects (e.g., Ajaokuta-Kaduna-Kano (AKK) pipeline) to ensure adequate, reliable, and affordable gas supply to existing and planned power generation facilities.

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