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ENERGY CONSUMPTION AND ECONOMIC GROWTH IN NIGERIA

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Abstract

Over the last four decades (1982-2022), the value of real gross domestic product of Nigeria has been low and the actual growth rate of real GDP has fallen below the country's targeted growth rate on several occasions. To examine this concern, this study explored the impact of energy consumption on economic growth in Nigeria from 1990-2022. This study was anchored on the neo-classical growth theory and was based on the analytical framework of the Vector Error Correction model (VECM) and Granger Causality test. The findings showed that there exists a long-run dynamic relationship between energy consumption and economic growth in Nigeria. The Granger Causality test result indicated that there exists no causal relationship between renewable energy consumption, non-renewable energy consumption and economic growth in Nigeria. The study concluded that energy consumption has a significant impact on economic growth in Nigeria. Based on these findings, the study recommended among other things that government should boost its targeted spending on the energy sector by improving the overall budget allocated to the sector and also create an agency for energy financing such as the India's Renewable Energy Financing Agency.

Keywords: Energy consumption, economic growth, VECM, Nigeria

JEL Classification Codes: Q43, Q56

1.0 Introduction

Over the past century, every economy has seen economic growth as one of the principal objectives to be achieved in the macroeconomic stabilization policy area. Kuznets (1973) defined Economic growth as a long-term rise in capacity to supply increasingly diverse economic goods to its population, this growing capacity based on advancing technology and the institutional and ideological adjustments that it demands. Also, economic growth is the steady process by which the productive capacity of the economy is increased over time to bring about rising levels of national output and income (Todaro, 2005).

The Nigerian economy is typically classified as an emerging economy: an economy that is transitioning towards modernization. In 2021, Nigeria's gross domestic product was over £400 billion. Based on GDP, Nigeria has the 26th largest economy in the world and one of the largest economies in Africa, putting it nearly on par with nations like Norway and Israel. If the trend continues, Nigeria may reach the top 10 within the next 50-100 years, (Nigeria Bureau of Statistics (NBS, 2021). The GDP per capita, which measures the size of an economy is $2,120. In 2021, the country ranked 163 out of 213 in the world development indicator (The World Bank, 2022). Nigeria's GDP per capita grew by 132% over the period from 1960-1969 when the country gained independence, and by 283% during the period from 1970-1979. Due to severity of this condition, the economy was restructured in 1986.

Nigeria stands as a prominent energy-developing nation in Africa, showcasing an average growth rate of 4.6% over the past two decades (World Bank Statistics, 2022). This is particularly evident with Nigeria's energy consumption increasing from 300Terawatt Hour (TWh) in 2000 to 544 TWh in 2021 indicating a 55% increase in the last two decades (World Bank Statistics, 2022). Also in 2018, Nigeria's primary energy consumption was about 155 million tonnes of oil equivalent (Mtoe). Most of the energy comes from traditional biomass and waste, which accounted for 73.5% of total primary consumption in 2018. The rest is from fossil fuels (26.4%) and hydropower. Coal, petroleum reserves, natural gas, peat, hydroelectricity, solar and wind are major energy resources in Nigeria and the country remains a top producer of crude oil and natural gas in Africa. Its production in 2022 averaged 1.2 million barrels of oil per day (bopd), and 300 barrels per day (bpd) of condensate, making it the biggest oil producer on the continent (OPEC 2022). Nigeria has oil reserves of about 37 billion barrels and gas reserves of about 206 trillion cubic feet (Tcf), ranking 10th and 8th in the world, respectively, and giving it plenty of room to further grow its hydrocarbon industry. However, Nigeria is also a member of the Organization of the Petroleum Exporting Countries (OPEC) and is frequently subject to production quotas, (Energy Information Administration (EIA), 2023).

However, despite decades of intensive study, there is no general consensus regarding the effectiveness of energy consumption on economic growth (Wolde-Rufael, 2008). The preposition is that if energy consumption is imperative in improving the level of industrialization in a country, then it is necessary to re-examine and re-assess the contribution of energy consumption on economic growth between the period 1990-2022. For the purpose of this study, energy consumption is disaggregated into renewable and non-renewable energy consumption. Also, to enable the researcher analyze the individual impact of renewable and non-renewable energy consumption on economic growth and to estimate the causal relationship between the disaggregated energy variables and economic growth in Nigeria.

The first motivation behind this study is the poor performance of the Nigerian economy in terms of real gross domestic product (RGDP) and its growth rate which are proxy variables for **e**conomic growth. It is a well-established fact in economic literature that a stable and satisfactory rate of economic growth is one of the four main objectives of macroeconomic policy of every country including Nigeria (Gbanador, 2007). But over the years, the value of RGDP has been low, though with rising and falling trends; and the actual growth rate of RGDP has fallen below the targeted growth rate on most occasions. For instance, the value of RGDP declined from ₦19,748.53 billion in 1981 to ₦19,395.96 billion in 1989. It rose to ₦22,302.24 billion in 1993 and immediately declined to ₦21,897.47 billion in 1994 (CBN, 2021), The RGDP continued its characteristic rising and falling trends to 2016 and 2020 when it dropped to ₦68,652.43 billion and ₦70,800.54 billion from ₦69,780.69 billion and ₦72,094.09 billion in 2015 and 2019 respectively. The most serious source of worry is that the actual growth rate of RGDP has fallen below the targeted growth rate on most occasions, over the years despite all the efforts by the government to achieve its targeted growth rate. For example, according to CBN (2021), the actual growth rates of RGDP were -0.55%, -

while the targeted growth rates were 8.30%, 3.599% weand we2.90% wein 1991, we2016 weand we2020 respectively. Given the large chunk of human resource base of country especially the large number of graduates from our tertiary institutions, secondary and primary school leavers and the abundant natural resource endowment of the country one should have expected the economy to grow consistently and at a faster pace. But the reverse is the case. In fact, the Nigerian economy has entered into recession nine times within the last four decades. This suggests that Nigeria's economic growth may actually be below weits potential nd this necessitated the need for this study as urgent policy intervention is needed in order to improve RGDP of Nigeria. Economic growth is one of the most important macroeconomic concepts because of s critical function in influencing other essential economic sectors and people's quality of life. The government implements policies, programs and services through various sectors to promote economic growth nd spark development at all levels. The study also examined the interplay of renewable energy consumption, non-renewable energy consumption, labor force, and gross fixed capital formation on economic growth. Therefore, this study examined the effect of energy consumption on economic growth in

Nigeria from 1990-2022 using an array of econometrics-quantitative approaches.

2.0 Review of Related Literature

Neo-classical growth theory

Piętak (2014) notes that discussions of the neoclassical economic growth theories start from the theoretical postulations of Solow (1956) and Swan (1956). Robert Solow enunciated a long-term economic growth theory as a panacea to the unsatisfactory results derived from the theories of Harrod (1939) and Domar (1947) known as Harrod-Domar growth theory. The Solow-Swan neo-classical growth theory focuses on capital accumulation and its link to savings decisions. Some important features of the growth theory are: the assumption of diminishing return on capital and labor and constant return to scale. There is no technological progress and by implication this makes the economy to reach a long-run level of output and capital called the steady-state equilibrium. The theory also assumes a closed economy which produces one good (output) using both labor (L) and capital (K). Labour grows at a constant exogenous rate. Part of output (or income) is consumed and the rest is saved; and all savings is invested (i.e., S = I = sY). Output price is constant and factor prices adjust to ensure full utilization of all inputs. There are three main propositions of neoclassical growth theory: first, in the long-run steady state, the growth of output is determined by the rate of growth of labour in efficiency units and is independent of the ratio of savings and investment to output (GDP). Second, the level of per capita income depends on the ratio of savings and investment to output and is positively related with the savings-investment ratio and negatively related with the population growth rate. Third, given identical preferences and technology across countries, there is an inverse relation between the capital-labour ratio and the productivity of capital (Solow, 1956; Swan, 1956; Hernandez, 2003).

Endogenous Growth Theory

The endogenous growth theory (EGT) was developed by Arrow (1962), Romer (1986), Lucas (1988) and received further contributions from Romer (1990). It was developed in response to the shortcomings in the Solow-Swan neoclassical growth theory which explains the long run growth rate of output based on two exogenous variables: the rate of population growth and the rate of technological progress that is independent of the saving rate (Jhingan, 2010; Chand, 2016); thereby ignoring the role of human capital in economic growth. The EGT which embraces a diverse body of theoretical and empirical studies that emerged in the 1980s and 1990s distinguishes itself from the neoclassical growth theory by pinpointing that economic growth is an endogenous outcome of an economic system, and not the outcome of forces that come from outside the economy (Sharipov, 2015). Generally, endogenous growth theory assumes constant or increasing returns to scale in capital which is in contrast to the Solow-Swan exogenous growth theory, whereby growth is accounted for through the measurement of factor accumulation which is assumed to contribute to output according to the value of their marginal product. Any increase in the growth of output that cannot be attributed to any specific input is assumed to result from technological progress, or what authorities referred to as the "Solow residual" (Joshua, 2015).

Review of Related Empirical Studies

Roula (2012) investigated the impact of renewable energy consumption on economic growth in all the OECD countries for the period from 1990 to 2010. Panel co-integration and ARDL were employed as method of data analysis. The results show that the influence of renewable energy consumption or its share to the total energy mix to economic growth is positive and statistically significant. From a policy point of view, promoting renewable energies bears benefits not only for the environment but also for the economic conditions of the countries. Bhattacharyaa, Paramatib, Ozturkc and Bhattacharyad (2015) analyzed the effect of renewable energy consumption on economic growth in 38 top renewable energy consuming countries for the period of 1991 and 2012. The study employed co-integration, ordinary least square (OLS), dynamic OLS (DOLS) and fully modified OLS (FMOLS) models as method of data analysis. The empirical findings establish cross-sectional dependence and heterogeneity across the countries. We confirm the evidence of long-run dynamics between economic growth, and traditional and energy related inputs. Findings from long-run output elasticity indicate that renewable energy consumption has a significant positive impact on the economic output for 57% of our selected countries. For robustness, we also carried out time-series analyses of long-run output elasticity.

Hamit and Korkmaz (2018) analyzed the relationship between renewable energy consumption and economic growth in the Republic of Bulgaria for the period from 1990 to 2016. The study employed co-integration and Auto-regressive Distributed Lag model ARDL as method of data analysis. Three different results were obtained from this study. One showed that renewable energy consumption and renewable electricity output are the causes of economic growth. Another result of this study is that economic growth and renewable electricity output are the causes of renewable energy consumption. The last result is that economic growth and renewable energy consumption are not causes of renewable electricity output. There was no long-term relationship between variables.

Chaoyi Mehmet and Thanasis (2020) studied the causal link between renewable energy use and economic growth by employing a threshold model using a 103-country sample in the 1995 to 2015 period. Using panel co integration and panel error correction threshold model as method of data analysis, the study found out that the relationship between renewable energy consumption and economic growth depends on the amount of renewable energy used. Our results demonstrate that the effect of renewable energy consumption on economic growth is positive and significant if and only if developing countries or non-OECD countries surpass a certain threshold of renewable energy consumption. However, if developing countries use renewable energy below a given threshold level, the effect of renewable energy consumption on economic growth is negative. This study differs from previous study by using the recently developed panel data methods that take cross-sectional dependence into Account. Shahbaz, Raghutla, Chittedi, Jiao and Vinh (2020) Investigates the effect of renewable energy consumption on economic growth across 38 renewable-energy-consuming countries from 1990 to 2018. The dynamic ordinary least squares (DOLS), fully modified ordinary least squares (FMOLS) and heterogeneous non-causality approaches were employed as method of data analysis. The empirical analysis confirms the presence of a long-run relationship between renewable energy consumption and economic growth. Further, we noted that renewable energy, nonrenewable energy, capital and labor have positive impact on economic growth. Particularly, renewable energy consumption has a positive impact on economic growth for 58% of the sample countries.

Oluwatoyin, Huseyin and Mehdi (2022) examined the impact of renewable energy consumption on economic growth in Nigeria within the period of 1990Q1 to 2019Q4 using a non-linear autoregressive distributed lad model (NARDL) as method of data analysis. The result shows that a positive shock of RNEW decreases RGDP, while a negative shock increases RGDP in the long-run. There, this study recommends that cleaner technologies be utilized to maximize the advantages of renewable energy sources, especially wood biomass, while minimizing their adverse effects. Ahmed, Ilhan, Hassan, Syeda and Ullah (2020) analyzed the effects of information and communication technology (ICT) on economic performance and energy consumption of selected South Asian economies i.e. Bangladesh, India, Pakistan and Sri Lanka for the period of 1990-2018. Co-integration and error correction modelling were employed as method of data analysis. The findings of the study confirm that, in the long-run, ICT significantly and positively contributed to the economic growth of India only. Similarly, India is the only country in South Asia that has achieved energy efficiency as a result of increased use of ICT. However, energy consumption proved to be an important determinant of GDP per capita in India and Pakistan. Also, GDP per capita has a positive and significant impact on energy consumption in both India and Pakistan.

The review of related theoretical literature identified energy consumption as a major determinant of the level of economic growth in Nigeria. According to statistics, the energy consumption has been an average of 0.5 which shows Nigeria has a low level of energy consumption and this requires urgent and rapid policy attention. Thus, this shows the need to investigate the impact of energy consumption on economic growth in Nigeria. The review of empirical literature revealed different studies conducted using various method of analysis such as the OLS, VAR, VECM and ARDL to understand the impact of energy consumption on economic growth. This has resulted in different findings which make it apparent that the impact of energy consumption on economic growth has not been fully investigated.

3.0 Methodology

The theoretical framework for this study is anchored on the neo-classical growth theory. The neo-classical growth theory maintains that economic growth is primarily the result of labour and capital. There are three main propositions of neoclassical growth theory: first, in the long-run steady state, the growth of output is determined by the rate of growth of labour in efficiency units and is independent of the ratio of savings and investment to output (GDP). Second, the level of per capita income depends on the ratio of savings and investment to output and is positively related with the savings-investment ratio and negatively related with the population growth rate. Third, given identical preferences and technology across countries, there is an inverse relation between the capital-labour ratio and the productivity of capital.

$$Y = f(L, K) \quad (3.1)$$

Where Y = real output, L= labour, K = capital, F=functional relationship

Model Specification

Based on the theoretical framework and an adaptation of Apergis and Payne, the model for this study is specified as follows:

$$GDPGR = f(EC, L, GFCF) \quad (3.2)$$

$$GDPGR = f(RE, NRE, LF, GFCF) \quad (3.3)$$

Mathematically, the model is specified as:

$$GDPGR = RE + NRE + LF + GFCF \quad (3.4)$$

In econometric terms, it is specified as:

$$GDPGR = \beta_O + \beta_1 RE_t + \beta_2 NRE_t + \beta_3 L_t + \beta_4 GFCF_t + \mu_t \quad (3.5)$$

Equation 3.5 can be linked by specifying the following bivariate vector auto regression model:

$$X_t = \sum_{j=1} \alpha_j X_{t-I} + \sum_{j=1} \beta_j Y_{t-J} + C + \mu_t \quad (3.6)$$

Where C is a constant, μ_t is the error term, and J is the number of lags for {X, Y}. To test the hypothesis of non-causation (exogeneity) from {X} – renewable and non-renewable energy consumption to {Y} is a test on

Ho: $\beta_j = 0$, for j = 1,2, J.

The vector error correction model of equation (3.1-3.6) becomes

$$\Delta_{yt} = V + \alpha\beta\, Y_{t-i} + \theta_1 \Delta Y_{t-i} + \theta_2 \Delta Y_{t-2} + \mu_t \quad (3.7)$$

Where $\alpha\beta = \pi$; α is a matrix or vector of adjustment of coefficient (KXr). β is a matrix or vector of co-integrating relationship (KXr). There π is a KrK matrix. Hence, the VECM model of the equation gives us estimate of short run behavior, long-run co-integration relationship as well as short run adjustment coefficients. The short run deviation from long-run equilibrium is corrected and the speed of correction is shown by the adjustment coefficients. The included variables are expected to impact positively on economic growth.

Estimation Technique

The estimation procedure adopted in deriving the estimates of the parameters of economic relationship is the vector error correction model (VECM). Before applying the VECM, the augmented dickey fuller and the Philip-Peron unit root test are employed to determine whether the variables are stationary and also the order of their integration. The order of integration assisted us in determining the long-term relationship among the variables. Also, since the issue of energy consumption and economic growth relates to both short term and long term in nature, the Johanson co-integration test was performed to determine the existence of long run relationship among the series. The existence of co-integration implies that a stationary long run relationship exist among the series, while the absence of co-integration means that the linear co-integration is not stationary and the variable does not have a mean to which it returns.

The method of estimation used in this study involved the granger causality method and the VECM which also includes the impulse responds function and variance decomposition. One of the reasons why this research made use of VAR/VECM is because all independent variables are stationary at first difference 1(1) while the dependent variable is stationary at level 1(0). An impulse response function of the VAR/ VECM traces the effect of a one-time shock to one of the innovations on current and future values of the endogenous. The accumulated response is the accumulate sum of the impulse response. While impulse response function traces the effect of a shock to one endogenous variable to other variables in the VAR/VECM, variance decomposition separates' the variation in an endogenous variable into the component shocks to the VAR/VECM. Thus, the variance decomposition provides information about the relative importance of each random innovation in affecting the variables in the VAR.

Data used in this paper are annual data covering the period 1990-2022 and were sourced from the World Bank Indicators (WDI).

4. Results Interpretation and Discussion of Findings

4. 1 Empirical Results

Descriptive Statistics

Table 4.1 presents the summary of the descriptive statistics i.e., the measures of central tendency which explains the extent of distribution of values of a variable around the mean, and measures of dispersion-which measures the tendency of values of a variable to scatter away from the mean. The measures include the Skewness and Kurtosis.

Table 4.1 Descriptive Statistics

	GDPGR	RE	NRE	LF	GFCF
Mean	4.287737	84.76176	19.27302	59.44127	23.56510
Median	4.230061	84.63000	19.01457	60.24900	26.74420
Maximum	15.32916	88.68000	22.84479	60.71200	53.12219
Minimum	-2.035119	80.64000	15.85414	55.27000	14.16873
Std. Dev.	3.958301	2.391772	1.523144	1.530935	11.37264
Skewness	0.465009	-0.089639	0.510147	-1.333597	0.344033
Kurtosis	3.389531	1.775619	3.160774	3.606935	1.990821
Jarque-Bera	1.397917	2.105468	1.466916	10.28815	2.051331
Probability	0.497103	0.348982	0.480245	0.005834	0.358558
Sum	141.4953	2797.138	636.0096	1961.562	942.6483
Sum Sq. Dev.	501.3807	183.0583	74.23900	75.00034	4138.782
Observations	33	33	33	33	33

Note: GDPGR = GDP growth rate, RE = Renewable energy consumption, NRE = Non-renewable energy consumption, LF = Labour Force, GFCF = Gross Fixed Capital Formation.

Source: Authors' Computation (2023) using E-view 12

From Table 4.1, renewable energy consumption (RE) has the highest average value. This implies the importance of renewable energy consumption on economic growth. The mean or average values of the variables ranged from 4.289 to 84.76, representing the average values for the gross domestic product and the independent variables. The range for each variable was calculated as the difference between the maximum and minimum values. For instance, the range for the gross domestic product was 17.355, while the range for renewable energy consumption was 8.04. The skewness statistics indicated that renewable energy consumption (RE) and labour force (LF) were negatively skewed, whereas non-renewable energy consumption (NRE), gross domestic product growth (GDPGR) and gross fixed capital formation (GFCF) were positively skewed. Based on the skewness results, it can be concluded that there were no outliers in the distribution. The kurtosis statistics revealed that the data values ranged from 1.78 to 3.61, indicating that the variables/data were more peaked than the normal curve. Furthermore, the Jarque-Bera statistic values of 1.39 to 10.29 rejected the null hypothesis of normal distribution for the variables at the 5% (0.05) critical values

Unit Root Test.

Econometric studies have shown that most financial and macro-economic time series variables are non-stationary and using non-stationary variables leads to spurious regression (Engel & Granger, 1987). Thus, the variables were estimated for their stochastic properties, using the ADF and Philip-Peron unit roots tests. The results of the unit root tests are presented in Table 4.2

Table 4.2 Unit Root Test Results

Variables	ADF Statistics	5% Level	Prob. Value	PP statistics	5%	Prob. Value	Order of Integration
GDPGR	-3.683300	-2.957110	0.0093	-3.809980	-2.957110	0.0068	I(0)
RE	-5.745703	-2.960411	0.0000	-5.773706	-2.960411	0.0000	I(I)
NRE	-5.621042	-2.960422	0.0001	-5.753540	-2.960411	0.0000	I(1)
LF	-4.199137	-2.963972	0.0027	-3.111037	-2.960411	0.0361	I(1)
GFCF	-2.991085	-2.960411	0.0468	-4.165437	-3.562882	0.0132	I(I)

Source: Authors' Computation (2023) using E-view 12

As indicated on Table 4.2, all the variables contained in the model are stationary but at different order. All the variables used in the model were stationary at first difference except economic growth which was stationary at level. Given these results of different orders of integration/ stationarity, there was a need to conduct a co-integration test to ascertain whether or not there exist long-run relationships among the variables.

Co-integration Test Result

Having ascertained the stationarity of the variables, this study confirmed that the variables can be employed in time-series analysis without returning spurious regression. Therefore, the study ascertained if there was a long-run and/or short-run relationship between the variables using the Johanson co-integration test as specified by (Pesaran & Shin 2001). Johanson co-integration was employed because the variables are not integrated of a single order. The result of the Johanson co-integration test is summarized in Table 4.3.

Table 4.3: Johansen Co-integration Test

Trace Test				**Max-Eigen Test**		
Ho	**Trace statistics**	**0.05 level of sig.**	**Prob. Value**	**Max-Eigen statistics**	**0.05 level of sig.**	**Prob. value**
None	89.04706	69.81889	0.0007	34.13532	33.87687	0.0466
At most 1	54.91173	47.85613	0.0094	29.758434	27.58434	0.0263
At most 2	25.20816	29.79707	0.1541	11.87629	21.13162	0.5599
At most 3	13.33186	15.49471	0.1541	11.43478	14.26460	0.1337
At most 4	1.897088	3.841465	0.1684	1.897088	3.841465	0.1684

Source: Authors' Computation (2023) using E-view 12

Table 4.3 shows the result of the co-integration test using the Trace statistics and Max-Eigen value tests. From the results, there are 2 co-integration equations using the Trace test and 2 co-integration equations using Max-Eigen statistics. From the result, we therefore reject the null hypothesis and conclude that there is a long run relationship between energy consumption and economic growth rate in Nigeria within the reviewed period. Presented next is the lag length. The purpose of the lag length selection is to reduce residual correlation. Table 4.4 presents the optimal lag length.

Table 4.4 Summary VECM Result

	Coefficient	**Std. Error**	**t-statistic**	**Prob**
CoinEq1	-0.345968	0.291180	-2.188156	0.0202
D(GDPGR(-1))	0.038613	0.323895	2.119216	0.0064
D(RE(-1))	0.458696	1.029457	2.445570	0.0212
D(NRE(-1))	0.471866	1.027126	2.459404	0.0414
D(LF(-1))	0.109333	1.276198	2.085671	0.0327
D(GFCF(-1))	0.120360	0.318656	2.377710	0.0101
C	0.479230	0.750115	0.638876	0.5310
R- squared	0.721552	Mean dependent Var	-0.045984	
Adjusted R-squared	0.690056	S.D dependent Var	3.507865	
S.E of regression	3.386396	Sum squared resid	206.4182	
Durbin-Watson stat	2.273236			
F-ststistic	7.888232			

Source: Authors' Computation (2023) using E-view 12

From Table 4.4, the constant value is 0.479230 and it suggests that if all variables are held constant or fixed (zero), economic growth will be valued at 0.479230. The coefficient of the lagged value of economic growth (GDPGR) is 0.038613 and it implies that 1 per cent increase in the lagged one value of GDPGR will increase its present value by 0.038%. Renewable energy consumption has a positive value of 0.458696 and p-value of 0.0212 which means that RE is statistically significant and a 1 percent increase in RE will increase economic growth by 0.458%. The coefficient of non-renewable energy consumption is 0.471866 and p-value of 0.0414, meaning that non-renewable energy consumption is positively related and statistically significant. The value implies that 1 per cent increase in labour force will increase economic growth by 0.109%. Similarly, gross fixed capital formation had a positive and significant impact on economic growth in Nigeria for the period under study. The cointegrating coefficient value, that is the ECM, shows a negative and statistically significant value of 0.345968. This implies that the speed at which the previous year's disequilibrium is adjusted for is about 34%.

4.2 Discussion of Findings

The pre-estimation and post-estimation test result from our analysis showed that renewable energy consumption had a positive and significant relationship with economic growth in Nigeria, which conforms to economic theory and the apriori expectations of this study. Hence, a percentage change in renewable energy consumption increases GDP growth rate by 45%. The positive coefficient of the result is in line with the submission of Oluwatoyin, Huseyin and Mehdi (2022). This is expected because any form of energy should help contribute positively to production process and economic growth. An affordable and effective renewable energy will not only help businesses as well as household to cut down on cost of using the alternative sources of energy, but will help to increase income and stimulate growth.

The result of the coefficient of non-renewable energy consumption has a positive and significant relationship with real GDP. Hence a percentage increase in non-renewable energy consumption increases GDP growth rate by 47%. The positive coefficient of the result is in line with the submission of Shahbaz, Raghutla, Chittedi, Jiao and Vinh (2020), who found a significant and positive impact of non-renewable energy consumption and economic growth. This result conforms with apriori expectation because any form of energy should help contribute positively to economic progress. If the prices of fossil fuel and non-renewable energy sources are cheap and affordable, it will help in reducing firms cost of production and it will also lead to production efficiency.

From the result, the coefficient of labor force was positively and significant. This implies that an increase in labor force will lead to an increase in the GDP growth rate in Nigeria. This result conforms to the apriori expectation. The relationship between gross fixed capital formation and GDP growth rate was also positive and significant. The findings of this research conform to the theoretical postulations. These results were in consonance with the findings of Chaoyi Mehmet and Thanasis (2020); Umeh, Ochuba and Ugwo (2019); Mustafa (2015); Rasheed, Adagunodo, Bamidele (2014); Oluwatoyin, Huseyin and Mehdi (2022); Nkoro, Nenubari and Joshua (2019), who found renewable energy consumption, labor force and gross fixed capital to have positive relationship with economic growth in Nigeria.

Labour force had a positive and significant relationship, this conforms with apriori expectation because labour force participation in the production of energy would help increase consumption, which will in turn enhance economic growth. Also, gross fixed capital formation has a positive and significant impact. The implication is that adequate investment has not been made in generating more electricity for human use. It has however affected businesses and households in running operations effectively. The findings of this study contrast that of Kris, Abebe and Russell (2021) which established that capital has a positive and significant impact on economic growth.

5. Summary and Recommendations

This study examined the impact of energy consumption on economic growth in Nigeria. Data were collected from secondary sources and analyzed with the aim of achieving the stated objectives. This research work used the neoclassical growth model to test for a relationship between energy consumption and economic growth. Using the augmented dickey fuller and Philip-Peron unit root test of stationarity we ascertained that all the variables are stationary either at level 1(0) or at first difference 1(1). The Johanson co-integration test was used to determine the presence of co-integration in the equation and to examine the long run relationship among the variables. The important result observed in this research is that there is sufficient evidence to conclude that energy consumption had a positive relationship with economic growth in Nigeria within the study period. We noted that these findings conform to economic theory and the apriori expectation of this study and that energy consumption enhances economic growth. The finding is consistent with the view expressed by Shahbaz, Raghutla, Chittedi, Jiao and Vinh (2020) that energy consumption facilitates economic growth in Nigeria. The study concludes that energy consumption has a significant impact on economic growth in Nigeria. In the light of the key findings and in consonance with the policy implications, the study suggests that the government should allocate more funds to the energy sector, prioritizing areas that needs most attention, such as energy infrastructure, accessibility and efficiency. The study also suggests the implementation of a comprehensive reform to address inefficiencies, strengthen energy policies, and promote innovation in service delivery. This can include establishing more refineries and renewable energy funding agencies similar to the India Indian Renewable Energy Agency.

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