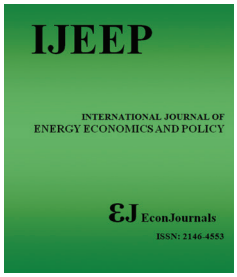

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Energy Absorption, CO_2 Emissions and Economic Growth Sustainability in Nigeria

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ABSTRACT

Economic growth sustainability and environmental preservation have become a topical issue. This study emanates from the need to assess the starring role of energy ingestion in guaranteeing sustainable economic progression in Nigeria. The study investigates the influence of energy consumption and carbon dioxide emission on the economic growth of Nigeria from 2008 to 2019. In this study, we employ the multiple regression techniques to assess the impact of Electricity, CO_2, primary energy and total labour force on GDP. Various indicative checks show that the model is appropriate and error-free. Out of the four energy sources examined, Electricity is found inconsequential in affecting the economic growth of Nigeria. The CO_2 emission is positively significant, implying that the economy is growing with a high level of pollution in the environment. The primary energy consumption put forth a substantial harmful effect on economic progress, while the total labour force has a strong significant affirmative impression on fiscal progression. The study suggests the use of renewable energy to preserve the environment and sustain economic growth in the country.

Keywords: Energy Consumption, CO_2, Electricity, Primary Energy, Labour Force, Sustainable Economic Growth
JEL Classifications: J82, L71, L72, L94, Q01, Q43

1. INTRODUCTION

Energy occupies a very important space in the growth of a nation's economy. Power is the primary input absorbed in all stages of production and manufacturing processes. The manufacturing sector of every country cannot function effectively without energy availability. The absorption of energy refers to the entire usage of power to perform an activity or produce goods and services (Nguyen et al., 2020). Energy consumption in African countries like Nigeria is very high and comprises primary energy, Electricity and human energy. The Energy Sector in Nigeria is very vital as the economy cannot thrive without sufficient and regular power supply, especially Electricity. In Nigeria, Electricity is in high demand and critical to the operations of all economic sectors. The fact is that the energy sources in Nigeria are non-renewable and challenging to sustain (Onabote et al., 2020). The bigger the energy ingestion, the more the carbon (CO_2) discharge emanating from absorption of relic energy (oil and gas). Fossil fuel creates virtually 75% of Nigeria's energy intake because rechargeable energy is still very insignificant to meet the increasing demand for power at the moment.

The pertinence of energy policies and regulation is now very crucial. The desire for an untainted and dependable source of energy to enhance living conditions in the country is passionately on the increase. The clamour to preserve the environment and reduce carbon (CO_2) emissions causing global warming and depletion of the ozone layer, has been a topical issue. Over the years, environmental protection and sustainability have been a secondary concern among Nigerians due to inadequate supply of Electricity for private sector operations. The public resort to any form of energy they can afford at all cost. The use of generators becomes very rampant and unabated. The worst scenario is the crude manner of refining oil to meet the growing local demands

for energy. The practice was more visible in the Niger Delta States of Nigeria, and it even got to a point where a Nigerian city known as Port Harcourt city in Rivers State was covered with black soot (Giles, 2018). The situation resulted in the loss of lives, abandonment of surrounding towns and communities due to hazards and continuous fire outbreaks. The intensive burning of fossil fuels in Nigeria is the product of unstable supply of Electricity that could have served as the best source of energy in the country (Chindo et al., 2015).

However, the importance of energy in Nigeria cannot be relegated to the background. Nigeria has a high population density and is also a high intensive energy consumption country. All manufacturing activities and production processes hinge on energy as a significant material input. Due to the high energy demand, scholars like (Okoye et al., 2020) advocate that, the right policies to encourage local refining of oil in Nigeria could be profitable. They would boost a sufficient supply of energy at an affordable rate. Although power is required to operate factory machines, it is also important to note that human power (physically and mentally) is necessary to augment the other forms of energy. In this study, we considered the total labour force in the country as the human energy in addition to other forms of energy used in Nigeria. It is worthy to note that out of 200,964,000 million (CBN, 2019) people in Nigeria, the total number of the working group is 62,447,230 million (World Development Indicators, 2020). This information goes further to stress the need for sufficient energy supply in the country, human and otherwise. As a unique part of the Millennium Expansion Objectives, job creation increases the labour force, decreases the rate of unemployment and alleviates the degree of insufficiency in the state (Omodero, 2019). The concept that sufficient energy availability is vital in boosting the economic growth of a nation is without a doubt.

2. LITERATURE REVIEW

2.1. Explanation of Notions

2.1.1. Renewable energy

Rechargeable power is sustainable energy derived from sources that restock themselves naturally without exhaustion in the earth (Owusu and Asumadu-Sarkodie, 2016). A maintainable power is referred to as a forceful synchronization, flanked by the unbiased obtainability of vitality concentrated merchandises and facilities to all persons, as well as safeguarding of the globe for upcoming generations (Tester, 2005). The restorable vivacity is clean and sustainable. Its natural supply helps to curtail carbon contaminations emanating from traditional sources of energy. Refreshable energy springs are energy bases from the natural and unrelenting current of energy trendy in our instantaneous surroundings (Owusu and Asumadu-Sarkodie, 2016). Energy from resident renewable sources guarantees stability in supply and offers numerous economic and social benefits (Tsagkari, 2020). The renewable energy sources include wind and ocean energy (tide and wave), direct solar energy, hydropower, geothermal energy and bioenergy (Owusu and Asumadu-Sarkodie, 2016). There is usually a free flow of energy from these natural sources, and it is never in short supply.

2.1.2. Primary energy consumption

Primary energy consists of traditional energy commonly used before the discovery of renewable energy which is environmentally friendly. In most countries, primary energy springs are relic petroleum like coal, oil and natural gas (Alper and Oguz, 2016). The global increasing energy requirement, besides growing inhabitants, occasioned continual usage of vestige fuel energy bases (Coal, Oil and Gas), which turned out to be problematical (Owusu and Asumadu-Sarkodie, 2016). Fossil fuels generated numerous challenges which include diminution of fossil fuel reserves, conservatory gas discharges, and other ecological distresses (Owusu and Asumadu-Sarkodie, 2016). Modern energy will minimize the consumption of traditional energy in emerging nations, to prevent glasshouse gas pollutions (Tariq et al., 2018). Apart from the greenhouse gas effluences, there were also frequent fuel price variations, geopolitical and military clashes (Owusu and Asumadu-Sarkodie, 2016). These complications might produce uncontrollable circumstances. The situation would ultimately lead to possible irrevocable hazardous conditions in society (UNFCC, 2015). Nevertheless, Tiwari and Mishra (2011) optimistically put forward that, renewable energy sources serve as the most acceptable and exceptional substitute that could fill the gap and remedy the hopeless situation at the moment.

2.1.3. Carbon (CO_2) emissions

CO_2 refers to all carbon dioxide generated in the course of gas flaring and ingestion of hard, liquescent, and fume energies. Carbon dioxide productions are the pollutions emanating from the sweltering of fossil fuels and cement manufacturing. Asumadu-Sarkodie and Owusu (2016) pose it that, the ascendency of energy generated from fossil fuels (Coal, Oil and Gas) and global population growth in the last decades increased energy demand. It becomes universally problematic and more complicated due to the growing rate of CO_2 productions.

2.2. Review of Related Empirical Works

Rafal et al. (2020) considered the association amid revivable vitality intake and cost-effective progression in 29 European republics. The study covered a period from 1995 to 2016. The econometric tools used were panel co-integration test, fully modified ordinary least squares method and dynamic ordinary least squares technique. The finding showed that renewable energy consumption in the European countries had a long-run equilibrium relationship with economic growth. The study further found that renewable energy consumption had a significant positive impact on economic growth. Nguyen et al. (2020) used quantitative research design and ARDL to assess the relationship between energy consumption and economic development in Indonesia from 2000 to 2019. The findings revealed that there was a nexus between economic growth and energy consumption in Indonesia.

Okoye et al. (2020) analyzed the relationship between energy consumption and economic growth in Nigeria from 1981 to 2017 using auto-regressive distributed lag (ARDL) technique. The study provided evidence that energy consumption is critical in the evolution of the Nigerian economy. Onabote et al. (2020) examined the relationship existing between energy sustainability, financing and economic growth of Nigeria from 1981 to 2014. The study

established a long to zrun relationship and also found the energy sustaining and financing variables affecting economic growth differently. Anochiwa et al. (2020) employed ARDL to assess the nexus between energy consumption and economic development in Nigeria from 1980 to 2017. The result showed that petroleum and Electricity were positive and significant to economic growth, while coal was found insignificant but positive. Khan et al. (2020) also applied ARDL to test the relationship between energy consumption, economic growth and carbon dioxide emissions in Pakistan. The study covered 1965 – 2015. From the findings, it was revealed that energy consumption and economic growth increase the CO_2 emissions in Pakistan, both in the short and long terms.

Tariq et al. (2018) examined energy consumption and economic growth of four developing countries from 1981 to 2015. The study found that a rise in the economic development of the countries also caused an increase in energy absorption. The paper also revealed that the nations were energy-dependent and thus, responded accordingly to energy shocks. The further finding showed that the rise in trade resulted in negative correlation with energy consumption. Alper and Oguz (2016) assessed the causal effect of renewable energy consumption on the economic growth of new EU member countries from 1990 to 2009. The study employed ARDL and found that renewable energy impacted positively and significantly on the countries examined.

Chindo et al. (2015) studied the relationship between energy consumption, CO_2 emissions and economic growth in Nigeria from 1971 to 2010 using ARDL co-integration approach. The study found among others that CO_2 emission had a significant positive impact on GDP. The findings also revealed that energy consumption had a significant adverse effect on GDP in the short run. Ogundipe and Apata (2013) employed the Johansen and Juselius co-integration technique to investigate the association between electricity consumption and economic growth of Nigeria from 1980 to 2008. The study established the existence of a bi-directional causal relationship and further revealed that electricity consumption impacted significantly on the economic development of Nigeria.

3. MATERIALS AND METHODS

The study makes use of causative exploration strategy which seeks to unravel the causality consequence of the explanatory variable on the response variable. Conferring to Kothari (2004), a causative investigation approach helps to discover the impact of one variable on another, and this is consistent with this study which tries to find the effect of energy absorption and CO_2 discharge on the fiscal progress of Nigeria. In this study, the reliant mutable is the GDP, and the data are collected from the Central Bank of Nigeria (CBN) Statistical Bulletin. The independent variables are 1. Primary Energy. The data are collected in Quadrillion Btu from the World Data Atlas. 2. CO_2 Emission. The data are gathered in Million Tonnes from the World Data Atlas. 3. Electricity Consumption. The data are derived in Billion Kilowatt Hrs from the U.S. Energy Information Administration. 4. The Total Labour force of Nigeria represents the working-class group out of the total population. The data were emanating from the International Labour Organization, World Bank Population Estimates and World Development Indicators. All data used in this study are a secondary form of data which span from 2008 to 2019 and are applied in their logarithm form. The study employs relevant statistical tools and software to carry out the data analysis.

The multiple regression model for this study to evaluate the impact of the independent variables on the dependent variable is specified as follows:

$$GDP = f(ELC, CO_2, PEC, TLF) \quad (1)$$

The econometric form is stated as:

$$LogGDP=\beta_0+\beta_1 LogELC+\beta_2 LogCO_2+\beta_3 LogPEC+\beta_4 LogTLF+\varepsilon \quad (2)$$

Where:
GDP =Gross Domestic Product
ELC = Electricity Consumption
CO_2 = Carbon dioxide emissions
PEC = Primary energy consumption
TLF = Total Labour Force
β_0 = Constant; β_1-β_4 = Regression coefficients; ε = Error term.
On the a priori, we expect; $\beta_1 >0$, $\beta_2 >0$, $\beta_3 >0$, $\beta_4 >0$.

4. RESULTS

The serial correlation test on Table 1 shows that the F-statistic P = 0.63 is more consequential than the 5% material level. Consequently, there is the nonexistence of serial correlation in the model applied in this research. The result of Durbin-Watson also validates this report.

The Ramsey Reset test is carried out to ascertain the stability of the regression model. The result in Table 2 discloses that the P = 0.128 is more significant than the 0.05 level of significance. Therefore, the product specifies that the model is firm. This is also established in Figures 1 and 2, where the blue line falls between the two red lines showing the boundaries at a 5% significance level.

The indicative test for Heteroskedasticity on Table 3 is to guarantee that the model coefficients assessed using ordinary least squares

Table 1: Breusch-Godfrey serial correlation LM test

F-statistic	0.504255	Prob. F (2,5)	0.6317
Obs*R-squared	2.014162	Prob. Chi-square (2)	0.3653

Source: Authors' calculation, 2020

Table 2: Ramsey RESET test

Specification: LOG_GDP LOG_CO_2 LOG_ELC LOG_PEC LOG_TLF C
Omitted variables: Squares of fitted values

	Value	Df	Probability
t-statistic	1.765124	6	0.1280
F-statistic	3.115662	(1, 6)	0.1280
Likelihood ratio	5.018815	1	0.0251

Source: Authors' calculation, 2020

are at liberty with prejudice. The presence of Heteroskedasticity is noticeable when the variance of errors or the model is not identical in the entire observations. In that case, the P-value of the F-statistic will be lower than the 5% level of significance. In this study, the P = 0.47, which is bigger than the 0.05 significance level. Thus, the model is Heteroskedasticity free. In the same manner, the P-value for Jarque-Bera in Figure 3, is 0.69 > 5%. The result provides evidence that the data set is normally distributed.

4.1. Histogram Normality

Multicollinearity existence test on Table 4 is with the Variance Inflation Factor (VIF). The test is to verify the existence of interrelationship among the independent variable. In this study, the value of 10 (Gujarati and Porter, 2009) applies to confirm if the explanatory variables have any interconnection in this study. The Australian Property Institute (2015) states that multiple regression models count on the proposition that all independent variables used in a study are not interconnected. The variables have VIFs that are below the value of 10. Thus, there is the absence of multicollinearity in the model.

The regression result in Table 5 indicates a strong and positive correlation between the economic growth of Nigeria and energy consumption. The correlation (R) value of 99% (square root of R-Squared) connotes a strong relationship between the response and explanatory variables. The coefficient of determination is also

Table 3: Heteroskedasticity test: Breusch-Pagan-Godfrey

F-statistic	0.994802	Prob. F (4,7)	0.4694
Obs*R-squared	4.349174	Prob. Chi-square (4)	0.3608
Scaled explained SS	0.605515	Prob. Chi-square (4)	0.9624

Source: Authors' calculation, 2020

Table 4: Variance inflation factors

Sample: 2008-2019
Included observations: 12

	Coefficient	Uncentered	Centered
Variable	Variance	VIF	VIF
LOG_CO_2	0.075135	11924.72	5.223020
LOG_ELC	0.034576	2558.847	6.996024
LOG_PEC	0.008012	8.566602	4.839958
LOG_TLF	0.088720	212410.7	5.980286
C	3.742861	149994.4	NA

Source: Authors' calculation, 2020

Table 5: Regression result
Dependent variable: LOG_GDP

Method: ARMA maximum likelihood (OPG - BHHH)
Sample: 2008 2019
Included observations: 12

Variable	Coefficient	Std. error	t-statistic	Prob.
LOG_ELC	0.075021	0.120452	0.622829	0.5607
LOG_CO_2	0.096297	0.034178	2.817547	0.0372**
LOG_PEC	−0.048384	0.020607	−2.347984	0.0657*
LOG_TLF	4.195262	0.170779	24.56538	0.0000***
C	−27.81071	1.120987	−24.80912	0.0000
AR (5)	−0.999104	0.003657	−273.1860	0.0000
SIGMASQ	1.03E − 06	3.11E − 06	0.332236	0.7532
R-squared	0.999965	Mean dependent var		4.898809
Adjusted R-squared	0.999922	S.D. dependent var		0.178503
S.E. of regression	0.001576	Akaike info criterion		−7.141928
Sum squared resid	1.24E − 05	Schwarz criterion		−6.859066
Log likelihood	49.85157	Hannan-Quinn criter.		−7.246654
F-statistic	23530.19	Durbin-Watson stat		2.018790
Prob (F-statistic) ***	0.000000			

Source: Authors' calculation, 2020. Significant at *10%; **5%; ***1%

Figure 1: Recursive estimates of the CUSUM test.
CUSUM = Cumulative Sum Control Chart

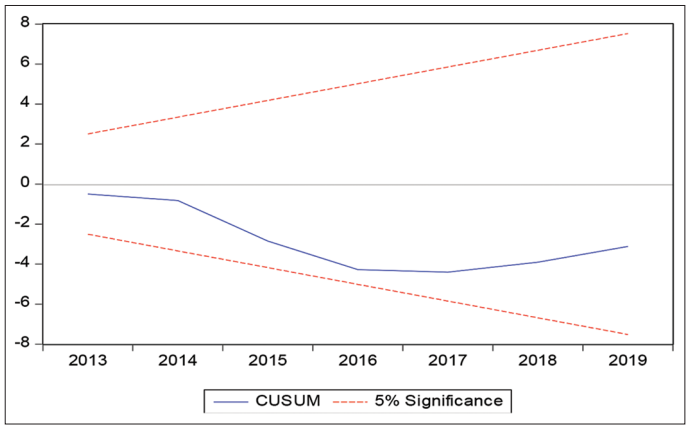


Figure 2: Recursive estimates of CUSUM of squares test.
CUSUM = Cumulative Sum Control Chart

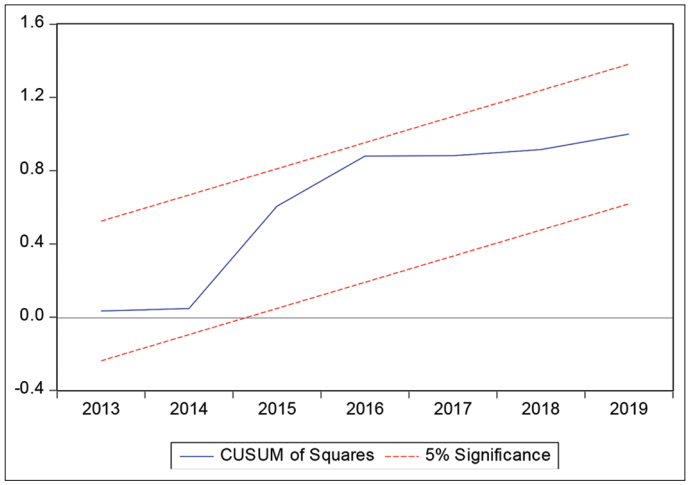
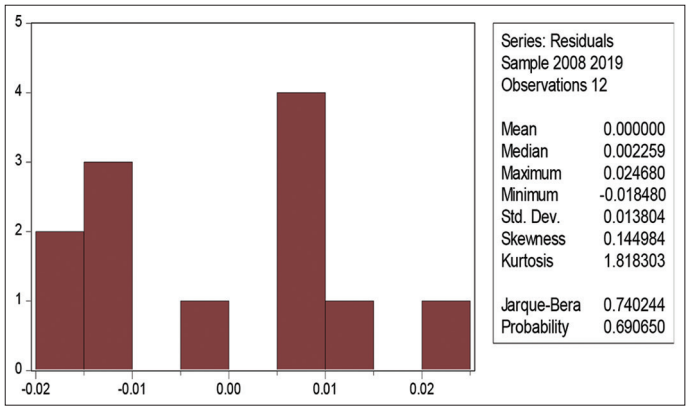


Figure 3: Normality test



99.99%, implying that the Nigerian economy depends so much on energy consumption. The various energy sources described here determine 99.99% of the changes in the economic growth of Nigeria, which is almost 100%. This is how vital energy means to the Nigerian economy. The research to identify the best source of energy to improve the economy and preserve the environment is indeed substantial. In this study, the result of the Standard Error of Regression is zero (0.00 <1). This result implies that the prediction is 100% accurate and the regression line is correctly fitted. The Durbin-Watson of 2 indicates the absence of autocorrelation and is confirmed by the serial correlation result in Table 1. The result of the F-Statistic is 23530.19 with a P = 0.00 significant at 1%. This result shows that the model used in this study is a good fit and statistically significant.

Figures 1 and 2 give the impression that the regression model if stable. The appearance of the blue line in between the frontiers of the dotted red lines shows the stability of the regression model.

The t-statistic of each explanatory variable provides evidence on the impact of each predictor variable on the response variable. The t-statistic of ELC is 0.623 while the P-value is 0.56 >0.05 significance level. The outcome specifies that Electricity has an insignificant effect on economic growth. The result clashes with the discoveries of (Ogundipe and Apata, 2013; Anochiwa et al., 2020). The CO_2 t-statistic is 2.817 with a P-value of 0.03 <0.05. The result reveals that CO_2 has a significant positive impact on the economic growth of Nigeria. This result is consistent with the findings of Chindo et al. (2015). The PEC t-statistic is −2.348, and the p-value is 0.06. This result is significant at 10%, which implies that PEC has a significant negative impact on economic growth. This finding is in line with the result of Chindo et al. (2015). Finally, the TLF has a t-statistic of 24.565 and a P = 0.00. The result is significant at 1% level of significant and implies that TLF has a noteworthy constructive bearing with growth. This finding is in agreement with the result of Nguyen et al. (2020).

5. CONCLUSION AND RECOMMENDATIONS

5.1. Conclusion

The research inspects the bearing of energy consumption with sustainable fiscal evolvement in Nigeria. The scope of the study is from 2008 to 2019. The independent variables employed to explain the variations in economic development through energy consumption include electricity consumption (ELC), carbon dioxide contaminations (CO_2), primary energy ingestion (PEC) and total labour force (TLF) in the country. The study found that Electricity does not impact significantly on economic growth within the period the study covers. This is as a result of epileptic and insufficient power supply which has affected the development of many businesses. Electricity in Nigeria is the best source of energy and ought to be regular, but the situation is pathetic. The policy implication is that, if the insufficient supply of Electricity in Nigeria continues, renewable energy expansion is, therefore, an emergency. Otherwise, CO_2 emission and its resultant effect on humans and the environment will remain unavoidable. From the result in Table 5, CO_2 has a weighty favourable influence on fiscal improvement. This is an indication that the economy is growing with the pollution emanating from the burning of fossil fuels. This result is a sign that, though the economy grows today, economic growth sustainability in the future is not guaranteed. The environmental degradation and the evaporation of the ozone layer is a serious issue of concern.

Nigeria is a place where people provide energy for themselves at all costs. The use of fossil fuels is inevitable for any business to remain in existence. However, the use of primary energy is negatively affecting the environment. The economy, as indicated by the result in Table 5. The product also illustrates that the total labour force has a substantial bearing with economic advancement. Thus, human energy (both mental and physical) is required to grow the economy. No wonder Omodero (2019) opines that human capital is the greatest asset in the economic growth of a nation and should be adequately developed to achieve national development.

5.2. Recommendation

The study recommends policies that would promote sufficient energy generation in Nigeria. Economic growth sustainability is all-encompassing. It integrates environmental sustainability for the future generation. If the environment is destroyed with the burning of fossil fuels to achieve economic growth, it will only be in the short run. Therefore, long-run economic growth requires a green energy policy. The implication of green energy policy in Nigeria is full adoption and implementation of renewable energy to reduce greenhouse gas emissions. Nigeria is naturally blessed and can benefit from refreshable energy springs (wind energy, ocean energy and solar energy) surrounding her territory.

Policymakers are encouraged to provide measures that will strengthen the energy sector and power generating agencies for effective and efficient service delivery. The government can only guarantee a clean and pollution-free environment if renewable energy is made available and affordable by the public. Its availability and affordability will help to minimize the usage of traditional energy sources that pollute our environment.

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