**ELECTRICITY CONSUMPTION AND ECONOMIC GROWTH IN NIGERIA: AN EMPIRICAL ANALYSIS FROM 1980-2021**

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**Abstract**

*This study examined the impact of electricity consumption and economic growth in Nigeria between the period 1980 and 2021. The study adopted the use of different variables like electricity consumption, carbon emission and greenhouse emission as the independent variables. While in the study, GDP per Capita was the proxy for economic growth which was the dependent variable. The study conducted a time-series unit root analysis to conform the stationarity of the series. The work employed the use of bound test and it showed that there is no co-integration between the variables. The study also tested the relationship between the variables and causality test was performed. The result revealed that there is a bi-directional relationship between electricity consumption, carbon emission, greenhouse emission and economic growth in Nigeria. The study therefore recommends that the government should make more investment in sustainable electricity generation that would positively stimulate energy consumption and increased economic growth in Nigeria.*

**Keywords: Impact, Electricity consumption, Carbon Emission, Greenhouse Emission, Economic Growth.**

**1. Introduction**

The 21st century is characterized with the demand of more energy. There has been rise in the demand for energy as it plays a crucial role in the development of the human society. Energy contributes immensely to the development of most nations as the industries within an economy is in need of it outputs (Olaniyan *et al*, 2018). Energy has taken diverse forms which are solar, hydro and tidal to mention but a few. One of the major used for of energy is from electricity. Almost all productive affairs of mankind make use of electricity as it aids in the transformation of resources from various states to the other. Adequate electricity supply is required for the growth of any economy as this aid the industrial sector (Akpan&Akpan, 2012).

There is great need to understudy the Nigerian economy as related to its electric energy harnessing, distribution and usage of this resource. Nigeria is known to be one of the largest producers of electricity in West Africa as it distributes most of its outputs to neighboring countries like Ghana, Chad and Cameroon. There are diverse means by which electricity is produced in Nigeria but one of the Major source of electricity in Nigeria is from the hydro-electric medium (Ogundipe&Apata, 2013).

The kanji-Dam is the major productive source of the Nigeria electricity while other sources provide a little scale of it total energy output. When the electric energy is produced in the Kanji-Dam within her economy there are different terminals in which the energy is distributed. Some of the recognized terminals in Nigeria are in Jebba, Niger state, Abuja, Lagos and others (Bakhsh *et al*, 2017).

The total watts of electric energy produced in the country are determined by the level of the complexity and sophistication of the energy sector. Though there is development and increase in the outputs from the Nigeria electricity sources but there is need for more improvement as there is increase in the demand for electricity (Olaniyan *et al*, 2018).

According to Umeji the recent rise in the Nigerian population to about 218 million has warranted for more outputs in electricity as the consumption in energy from her economy from both internal and external agents has increased. As at June 2022, the Transmission Company of Nigeria(TCN) generates about 92.71watts of energy which is an improvement to the previous energy output of 90.69 watts but is still less than what the economy demand (Umeji *et al*, 2023).

There are different factors that had led to the rise in electricity consumption in Nigeria some of which are the increase in the numbers of companies established within the country, increase in her population, rise in productive activities within the economy and need for more industrialization in the country (Oteh *et al*, 2021).

Over the years there are different factors that had affected the growth of her economy one of which is the poor access to electricity supply which affected most of her productive activities. The efficient management of her electricity generating sources and effective utilization of the produced energy would aid growth in her economy as compared to other economies in the international market (Oyedepo *et al*, 2018).

Nigeria had begun generating and distributing energy in the country since 1898 and had evolved overtime to become what it is presently. Different scholars have researched about the impact of energy on the growth of an economy while other scholars have specified the form of energy like electricity impact on economic growth (Elehinafe *et al*, 2022).

The need for development in the energy and industrial sector have encouraged many scholars to research on the transitions experienced within the Nigerian electricity generation. This is major reason why this work is conducted to provide detailed insight about the electricity, electricity consumption and economic growth in Nigeria. This provides a structured objectives as which this work would be written (Olaniyan *et al*, 2018).

There are different questions which this research would seek to provide answer to some of which are: does electricity consumption affect economic growth in Nigeria?, what have been the trend of electricity consumption in Nigeria between 1981 to 2020?, what kind of impact does electricity consumption has on economic growth in Nigeria?

This work is thus structured into different segments to aid in easier understanding of the work. The work began with a background study on electricity consumption and economic growth in Nigeria. The next part of the work would be reviewing the different selected literatures that would relevant to this work. We would explain various theories that are relevant for this work. Following the theories would be the trends of the various variables and explanation on the methodology that would be adopted in this work. This would further aid in the results and conclusion gotten to at the end of the work.

**2. Literature Review**

**2.1 Theoretical Literature**

There are different theories relevant to electricity consumption and economic growth. Some of such theories are explained in the section below:

**2.1.1 The Growth Hypothesis Theory**

The growth hypothesis theory was introduced by Albert Hirschman**.** The theory reveals that energy consumption especially electricity have a great effects on economic growth in Nigeria. This theory explains that this level of growth as affected by energy consumption is influenced by two (2) factors which are labor and capital (Hirschman, 1977). It is understood here that energy consumption have a unidirectional effects with economic growth and there is need to observe the diverse changes introduced by labor and capital. The hypothesis explains that there is need to implement policies within the energy sector to regulate the rate at which energy like electricity are consumed. In this situation when energy are produced but regulated by energy policies when the policies reduces the usage of energy especially for conservative purposes then there is possibilities for negative impact on the economy and otherwise when reduced. In this theory it is a unidirectional causality that exits from energy consumption on economic growth within a country (Matthew *et al*, 2018).

**2.1.2 The Conservative Theory**

This is another theory that is recognized within the energy sector. The theory was introduced by Edmund Burke**.** The theory explains that both energy and economic growth are crucial within and an economy (Jones, 2017). He emphasized that economic growth is influenced by energy produced and consumed. Economic growth within a nation always triggers the need for more energy consumption which relatively impacts the economy. According to this theory it is economic growth that influences energy consumption. This is because energy consumption is a broader concept and energy consumption is a smaller variable. As the economy grows the industrial sector and even productivity would warrant that more energy are consumed. In this theory it is a unidirectional causality that exits from economic growth on energy consumption (Afolayan, 2019).

**2.1.3 The Feedback Hypothesis**

This is another theory within the energy sector that reflects the relevance of energy consumption within an economy. This theory was introduced by Friedrich Hayek**.** It is quite similar to the growth hypothesis and the conservative hypothesis introduced by Albert and Edmund Burke**.** The theory also posits that economic growth is influenced by energy consumption but there is more to this theory. The theory is different theories because it explains that both economic growth and energy consumption within an economy have bidirectional causality among themselves. This indicates that both economic growth and energy consumption affects each other. In summary according to this theory economic growth is influenced by energy consumption and similar is the scenario as energy consumption is influenced by economic growth (Ogundipe *et al*, 2016).

**2.1.4 The Neutrality Hypothesis**

The theory was introduced by the Cambridge economics traditionalist**.** This is another theory that is very relevant within the energy sector. The theory did not make major emphasis on the introduction of energy policies on the economy as there is a less relationship between energy consumption and economic growth within a nation. The theory explains that there is a non-causality between economic growth and energy consumption within a nation. This theory is tend to be applied when an economic situation exits that there is no relevance for energy policies within an economy to reduce the consumption of energy like electricity within the society (Oyedepo *et al*, 2018).

**2.2. Empirical Review**

Quite a number of studies have been conducted on the relationship between electricity consumption and economic growth. Prominent among these studies are: Ahmad *et al* (2017) carried out research on the causal effects and relationships between electricity consumption and economic growth in ASEAN. The research adopted the use of granger causality test which was used in reflecting the relationship between electricity consumption and economic growth in the ASEAN. It adopted the use of panel data and it showed that there was no causal relationship between the variables in the short-run but in the long-run there exists a form of bidirectional relationships between electricity consumption and economic growth among the ASEAN nations.

Dantama *et al* (2012) carried out research on the causal effects and relationships between energy consumption and economic growth in Nigeria and they observed that there is a bi-directional relationship between energy consumption and economic growth in Nigeria. This was reflected after the causality was tested.

Akpan (2012) emphasized on the relationship between electricity consumption, carbon emissions and economic growth in Nigeria. He adopted the use of granger causality test and co-integration test and it was revealed that there exist a long-run and causal relationship between electricity consumption, carbon emission and economic growth in Nigeria.

Mamudu *et al* (2020) conducted an empirical analysis on the impact of electricity consumption and economic growth in Nigeria. In observing the impact of electricity consumption and economic growth in Nigeria and their findings were a direct and significant impact among the variables. They adopted the use of Johansen co-integration test and after which they did stability test on the variables. The results show that there is a 5% critical value the CUSUM shows stability. There is a long-run equilibrium between electricity consumption and economic growth.

Morimoto and Hope (2001) focused on the correlation between electricity use and economic growth in Nigeria and they revealed that there is strong correlation between both variables and there was causality between the variables when the granger causality test was adopted.

Ogundipe and Apata (2013) focused on the impact of energy consumption and economic growth in Nigeria between the period 1980 and 2008. They adopted the use of Vector Error Correction model and the Pairwise Granger causality technique in his work. It was revealed in their work that there was long-run relationship between energy and economic growth in Nigeria.

Olaniyan *et al* (2018) performed another research investigating the relationship between electricity consumption, institution and economic growth in Nigeria. They adopted the use of bound test in performing the auto-regression for the variable. It showed that there is a long-run relationship between electricity consumption, institutional quality and economic growth in Nigeria.

Having reviewed the literature so far, it was discovered that there was conflicting results that emanated from the diverse studies while some studies asserted that there is uni-directional causality from electricity consumption to economic growth and others observed a bi-directional causality between both variables. The study therefore is motivated to dig deep into the relationship to ascertain the actual causality between electricity consumption and economic growth with particular reference to Nigeria.

**3. Stylized Facts on Electricity Consumption and Economic Growth in Nigeria from 1980 to 2021**

**3.1 Trend in GDP per Capita in Nigeria from 1980 to 2021**

Figure 3.1: GDP Per Capita of Nigeria

(Author’s computation, 2023)

Figure 3.1 above shows the trend of economic growth in Nigeria which is proxy with GDP per capita of Nigeria. The graph shows that the GDP per capita have been upward sloping since 1980 till 2020 which is the year understudied. The least GDP per capita experienced by Nigeria was N689 in 1980 while the highest GDP per capita experienced within the country was N825, 090. This reflects that there has been economic growth within the country after the post-independence period. The Nigerian GDP per Capita has been ever increasing when observed from the diagram above. What is much relevant to most scholars is that its impact on her economy is reflected by her real GDP and this determines that level of growth experienced within the economy.

**3.2 Trend in Electricity Consumption in Nigeria from 1980 to 2021**

The diagram below shows the trend of electricity consumption in Nigeria between 1980 and 2021.

Figure 3.2: Trend in Electricity consumption in Nigeria From 1980 to 2021

(Author’s computation, 2023)

The Figure 3.2 above is the illustration of the electricity consumption in Nigeria based on the time frame understudied. Electricity consumption within the country have been fluctuating annually but in an upward sloping trend. This reflects that there had been increase in the demand for electric power within the country for diverse purposes like production within the industrial sector. It is revealed in the graph above that the Nigerian economy had it least electricity consumption in 1981 which was 51 Kwh while it had it highest electricity consumption of 154 Kwh in 2012. The electricity consumption have been increasing within the Nigerian economy because our population is increasing and there is more demand for its outputs and in doing so more electricity is consumed from the different sectors within the nation.

**3.3 Trend in Carbon Emission in Nigeria**

The diagram below shows the trend of carbon emission in Nigeria between 1980 and 2021.

Figure 3.3: Trends in Carbon Emission in Nigeria From 1980 to 2021

(Author’s computation, 2023)

The diagram above shows the trend of carbon emission in Nigeria between the period 1980 and 2021. In 1980 the carbon emission within the country was 476 but the trend of carbon emission have been fluctuating but at an ever decreasing rate. This reflects that the level of carbon emitted within the Nigerian economy has been reducing. These are due to different factors like increase in demand for human friendly energies, reduction in carbon emitted from different energy source. The emission have been fluctuating because there have been increasing demand for energy. The higher the energy consumption within the nation the higher the level of production experienced within the nation and thus improvement in the economic growth of the nation. For the economy to improve then there is need to properly check and manage the carbon emitted from different sector of the economy to reduce it negative impact on growth. From the diagram above it was revealed that Nigeria had it highest carbon emission in 1980 which was 476 while it least carbon emission was in 2000. In every successive period from 1980 till 2001 there been fall in the carbon emission within the country but the country started experiencing increase in carbon emission from 2002 till date.

**3.4 Trend in Greenhouse Emission in Nigeria**

The diagram below shows the trend of greenhouse emission in Nigeria between 1980 and 2021.

Figure 3.4: Trend in Greenhouse Emission in Nigeria from 1980 to 2021

(Author’s computation, 2023)

The diagram above shows the trend of greenhouse emission in Nigeria between the period 1980 and 2021. In 1990 the greenhouse emission within the country was 219390 but the trend of greenhouse emission has been fluctuating at an increasing rate. The greenhouse emission experienced within the economy is much that it affects the economic growth of Nigeria. The reason for this is because there have been more greenhouses established at different regions within the country because of the need for increased productivity. The higher the number of greenhouses within the economy especially for agricultural productivity the higher the emission from the structure. After showing the trend of electricity and energy consumption within the economy it is relevant to reflect the trend of electricity consumption, energy consumption and economic growth within the nation.

**3.5 Trend in GDP, Electricity Consumption and Energy Consumption in Nigeria**

The diagram below shows the trend of GDP per capita, electricity consumption, carbon emission and greenhouse emission in Nigeria between 1980 and 2021.

Figure 3.5: Trend in GDP per Capita, Electricity consumption, Carbon Emission and Greenhouse Emission in Nigeria From 1980 to 2021

(Author’s computation, 2023)

Figure 3.5 shows the trend of the economic growth of Nigeria represented with GDP per Capita, the electricity consumption, carbon emission and greenhouse emission in Nigeria between 1980 and 2021. From the diagram above we can observe that economic growth and electricity consumption have been upward sloping while the trend of carbon emission and greenhouse emission have been on an almost constant. The reason for this both for carbon emission and greenhouse emission is because there have been need to reduce both carbon and greenhouse emission as they both affect the society and their aftermath effect is reflected on the economy. Electricity consumption, carbon emission and greenhouse emission have impact on economic growth in Nigeria. Nigeria had it highest GDP per Capita in 2021 which was N825090 while the largest energy consumption and electricity consumption was in 2012 which N785 and N154 respectively.

**4. Methodology**

This aspect of the work would be segmented into three parts which are the model specification, estimation techniques and the interpretation of the results.

**4.1 Model specifications**

This work would be building upon the previous work conducted by Ogundipe and Apata (2013) on the impact of energy consumption on economic growth in Nigeria. He adopted the recognized Cobb-Douglass functional form in his work. This technique adopted by Ogundipe *et al* (2013) is very important as the Cobb-Douglass functional form is relevant in production. In obtaining this result the inputs and outputs for the production function must be recognized.

The Cobb-Douglass functional form in production is depicted as thus:

$Q = A Lα Kβ$…………………………………………………………………… eqn 1

Q = Quantity of production, L= Labor and K= Capital

This work improved on the efforts of Ogundipe and Apata that focused majorly on energy consumption and economic growth in Nigeria. The new model for this work is shown in the model estimation.

**4.2 Estimation Techniques**

The estimation techniques used in this work is an improvement of Ogundipe and Apata work which compared Gross Domestic Product as the dependent variable with the independent variable which was Energy Consumption. The model that would be used in this work is written as follow

GDP = f (ELC, CAR&GRE)

Where,

GDP which is Gross Domestic Product is the proxy for economic growth,

ELC which is the acronym for Electricity consumption in Nigeria and

CAR which is the acronym for Carbon Emission in Nigeria

GRE which is the acronym for Greenhouse Emission in Nigeria

**4.3 Interpretation of Results**

The next section of this work after the model specification and the model estimation would be to interpret the results gotten from the analysis of the work. The analysis that would be carried on this work would include the ordinary least square test, the unit root test, the autoregressive distributed lag test and the causality test.

**4.3.1 OLS Test**

The Ordinary Least Squares test would be conducted to test also the stationarity of the variables.

|  |  |
| --- | --- |
| Dependent Variable: GDP\_PER\_CAPITA |  |
| Method: Least Squares |  |  |
| Date: 02/20/23 Time: 22:14 |  |  |
| Sample: 1980 2021 |  |  |
| Included observations: 42 |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob.   |
|  |  |  |  |  |
|  |  |  |  |  |
| ELECTRICITY\_CONSUMP | -2471.891 | 771.1947 | -3.205275 | 0.0027 |
| CARBON\_EMISSION | -577.6697 | 400.3946 | -1.442751 | 0.1573 |
| GREENHOUSE\_EMISSION | 0.447784 | 0.361566 | 1.238457 | 0.2231 |
| C | 389581.0 | 105541.5 | 3.691257 | 0.0007 |
|  |  |  |  |  |
|  |  |  |  |  |
| R-squared | 0.348197 |     Mean dependent var | 203776.9 |
| Adjusted R-squared | 0.296739 |     S.D. dependent var | 250355.1 |
| S.E. of regression | 209949.4 |     Akaike info criterion | 27.43751 |
| Sum squared resid | 1.67E+12 |     Schwarz criterion | 27.60301 |
| Log likelihood | -572.1878 |     Hannan-Quinn criter. | 27.49817 |
| F-statistic | 6.766618 |     Durbin-Watson stat | 0.169902 |
| Prob(F-statistic) | 0.000909 |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

From the result above it is revealed that electricity consumption and carbon emission negatively affect GDP per capita by 2471 and 577 respectively while greenhouse emission positively affects GDP by 0.447. The findings from this result shows that a one percent change in the independent variables would affect GDP by 34%. Even from the Durbin Watson the variables are positively correlated as the Durbin-Watson value is 0.169 which is less than 2.

**4.3.2 Unit Root Test**

The table below shows the summary of the unit root test using the Augmented Dickey Fuller Test.

|  |  |  |  |
| --- | --- | --- | --- |
| **VARIABLES** | **ADF VALUES** | **CRITICAL VALUES (5%)** | **STATIONARITY** |
| GDP | 8.6320 | 2.9350 | I (0) |
| ELECTRICITY CONSUMPTION | 6.6661 | 2.9369 | I (1) |
| CARBON EMISSION | 4.0001 | 2.9369 | I(0) |
| GREENHOUSE EMISSION | 6.1242 | 2.9369 | I(1) |

From the result of the unit root test is reflected that both electricity consumption and greenhouse emission were stationary at first difference with ADF values of 6.6661 and 6.1242 respectively while GDP and carbon emission were stationary at level with ADF values of 8.6320 and 4.001.

**4.3.3 The ARDL Test**

The co-integration of the variables would be conducted using the ARDL Test. This would be show more details on the relationship between the variable either there is a short or long-run relationship.

|  |  |
| --- | --- |
| Dependent Variable: GDP\_PER\_CAPITA |  |
| Method: ARDL |  |  |  |
| Included observations: 38 after adjustments |  |
| Maximum dependent lags: 4 (Automatic selection) |
| Model selection method: Akaike info criterion (AIC) |
| Dynamic regressors (4 lags, automatic): ELECTRICITY\_CONSUMPTION |
|         CARBON\_EMISSION GREENHOUSE\_EMISSION   |  |
| Fixed regressors: C |  |  |
| Number of models evalulated: 500 |  |
| Selected Model: ARDL(4, 0, 2, 1) |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Variable | Coefficient | Std. Error | t-Statistic | Prob.\*   |
|  |  |  |  |  |
|  |  |  |  |  |
| GDP\_PER\_CAPITA(-1) | 0.797726 | 0.161438 | 4.941367 | 0.0000 |
| GDP\_PER\_CAPITA(-2) | 0.162563 | 0.231422 | 0.702455 | 0.4884 |
| GDP\_PER\_CAPITA(-3) | -0.416336 | 0.264269 | -1.575422 | 0.1268 |
| GDP\_PER\_CAPITA(-4) | 0.645140 | 0.185516 | 3.477547 | 0.0017 |
| ELECTRICITY\_CONSUMPTION | 324.1671 | 68.67998 | 4.719966 | 0.0001 |
| CARBON\_EMISSION | -65.53874 | 33.72444 | -1.943361 | 0.0625 |
| CARBON\_EMISSION(-1) | 5.905219 | 42.98015 | 0.137394 | 0.8917 |
| CARBON\_EMISSION(-2) | -69.84966 | 34.23337 | -2.040397 | 0.0512 |
| GREENHOUSE\_EMISSION | 0.045449 | 0.028150 | 1.614531 | 0.1180 |
| GREENHOUSE\_EMISSION(-1) | -0.095280 | 0.032698 | -2.913928 | 0.0071 |
| C | 1093.343 | 7424.015 | 0.147271 | 0.8840 |
|  |  |  |  |  |
|  |  |  |  |  |

From the results gotten after the ARDL test was conducted we can see that there is a short run relationship between electricity consumption, carbon emission, greenhouse emission and GDP as the probability of the constant is greater than 5%. So we would be conducting the co-integration test using the bound test.

**4.3.4 Bound Test**

In conducting the co-integration test to check for the relationship we would be using the bound test. It is shown below:

|  |  |  |
| --- | --- | --- |
| ARDL Bounds Test |  |  |
| Date: 02/20/23 Time: 23:16 |  |  |
| Sample: 1984 2021 |  |  |
| Included observations: 38 |  |  |
| Null Hypothesis: No long-run relationships exist |
|  |  |  |  |  |
|  |  |  |  |  |
| Test Statistic | Value | k |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| F-statistic |  3.298290 | 3 |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Critical Value Bounds |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| Significance | I0 Bound | I1 Bound |  |  |
|  |  |  |  |  |
|  |  |  |  |  |
| 10% | 2.72 | 3.77 |  |  |
| 5% | 3.23 | 4.35 |  |  |
| 2.5% | 3.69 | 4.89 |  |  |
| 1% | 4.29 | 5.61 |  |  |
|  |  |  |  |  |
|  |  |  |  |  |

The result of the co-integration after using the bound test reflects that there is no co-integration between the dependent and the independent variables. The F-statistics value is less than theI(1) bound so we accept the null hypothesis that there is short run relationship.

**4.3.5 Causality Test**

In conducting the causality test the Granger Causality test would be used and it is shown below:

|  |  |  |  |
| --- | --- | --- | --- |
|  |  |  |  |
|  Null Hypothesis: | Obs | F-Statistic | Prob.  |
|  |  |  |  |
|  |  |  |  |
|  ELECTRICITY\_CONSUMPTION does not Granger Cause GDP\_PER\_CAPITA |  40 |  1.34172 | 0.2745 |
|  GDP\_PER\_CAPITA does not Granger Cause ELECTRICITY\_CONSUMPTION |  4.35963 | 0.0204 |
|  |  |  |  |
|  |  |  |  |
|  CARBON\_EMISSION does not Granger Cause GDP\_PER\_CAPITA |  40 |  1.58461 | 0.2194 |
|  GDP\_PER\_CAPITA does not Granger Cause CARBON\_EMISSION |  0.53462 | 0.5906 |
|  |  |  |  |
|  |  |  |  |
|  GREENHOUSE\_EMISSION does not Granger Cause GDP\_PER\_CAPITA |  40 |  3.06705 | 0.0592 |
|  GDP\_PER\_CAPITA does not Granger Cause GREENHOUSE\_EMISSION |  1.38814 | 0.2629 |
|  |  |  |  |
|  |  |  |  |
|  CARBON\_EMISSION does not Granger Cause ELECTRICITY\_CONSUMPTION |  40 |  0.18526 | 0.8317 |
|  ELECTRICITY\_CONSUMPTION does not Granger Cause CARBON\_EMISSION |  1.00342 | 0.3769 |
|  |  |  |  |
|  |  |  |  |
|  GREENHOUSE\_EMISSION does not Granger Cause ELECTRICITY\_CONSUMPTION |  40 |  0.56177 | 0.5753 |
|  ELECTRICITY\_CONSUMPTION does not Granger Cause GREENHOUSE\_EMISSION |  2.24001 | 0.1215 |
|  |  |  |  |
|  |  |  |  |
|  GREENHOUSE\_EMISSION does not Granger Cause CARBON\_EMISSION |  40 |  7.84269 | 0.0015 |
|  CARBON\_EMISSION does not Granger Cause GREENHOUSE\_EMISSION |  0.03727 | 0.9635 |
|  |  |  |  |
|  |  |  |  |

The result from the granger causality test shows that there is causality between the independent variables which are electricity consumption, carbon emission and greenhouse emission and the dependent variable which is GDP per capita. There is a bi-directional relationship between all the variables as all affects one another.

**5. Conclusion**

This work provided insights on the relationship between economic growth, electricity consumption, carbon emission and greenhouse emission in Nigeria. Economic growth was proxied with GDP per capita while the total electricity consumption was proxied with electricity consumption, carbon emission with total carbon emission within the economy and greenhouse emission by the total emission from the greenhouses on the economy. The focused on the period between 1980 and 2021. The statistical techniques used in this work were the unit root test, the autoregressive distributed lag (ARDL) test, the ordinary least squares (OLS) test and the granger causality test. The unit root test showed that GDP per capita was stationary at level while electricity consumption and energy consumption was stationary at first difference. The results of the granger causality test showed that all the variables cause one another and from the test above the variables were correlated. Finally the ordinary least squares test showed that a one percent change in the independent variables it would affect the dependent variables by 34%.The results shows that there is no co-integration when the bound test was adopted and GDP was the dependent variable.

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**Data**

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **YEAR** | **GDP\_PER\_CAPITA** | **ELECTRICITY\_CONSUMPTION** | **CARBON\_EMISSION** | **GREENHOUSE\_EMISSION** |
| **1980** | 689.088533263888 | 68.49762072548014 | 476.71 | 0 |
| **1981** | 1853.139811039483 | 51.08054847792137 | 286.026 | 0 |
| **1982** | 1926.023236889998 | 81.93769719044669 | 161.348 | 0 |
| **1983** | 2000.592411347645 | 81.80050742779105 | 154.014 | 0 |
| **1984** | 2039.085186641895 | 62.14841501317356 | 201.685 | 0 |
| **1985** | 2247.174043779566 | 80.43285052766068 | 370.367 | 0 |
| **1986** | 2309.015079858867 | 90.84638470722612 | 297.027 | 0 |
| **1987** | 2779.061549742063 | 89.30742923436841 | 205.352 | 0 |
| **1988** | 3493.195374348488 | 87.18176097793741 | 161.348 | 0 |
| **1989** | 4473.179654171721 | 97.11672759994644 | 143.013 | 0 |
| **1990** | 5195.058876319331 | 87.07729557769905 | 165.015 | 219390 |
| **1991** | 6040.411134278462 | 89.58353636614535 | 190.684 | 235360.000610352 |
| **1992** | 9043.829068372482 | 90.03609379305444 | 139.346 | 250039.993286133 |
| **1993** | 12232.24682758672 | 100.8119982721557 | 22.002 | 246800.003051758 |
| **1994** | 16772.77213145361 | 95.41409170549712 | 66.006 | 241789.993286133 |
| **1995** | 28656.10113487118 | 91.28586905653984 | 51.338 | 246080.001831055 |
| **1996** | 36825.93521985161 | 85.68247161133869 | 22.002 | 262049.987792969 |
| **1997** | 38831.73290555795 | 81.76380557997725 | 25.669 | 254380.004882813 |
| **1998** | 41178.63324758145 | 76.72430856362488 | 33.003 | 235899.993896484 |
| **1999** | 45802.48500685886 | 75.49151883781159 | 44.004 | 225839.996337891 |
| **2000** | 57489.9227382441 | 74.14613670382401 | 7.334 | 235929.992675781 |
| **2001** | 65274.02993141375 | 75.11532969597364 | 7.334 | 243070.007324219 |
| **2002** | 88757.38400490818 | 103.8639119293294 | 113.677 | 227449.996948242 |
| **2003** | 101840.3992941666 | 100.9917375101845 | 62.339 | 246710.006713867 |
| **2004** | 132527.623188566 | 122.3339104744502 | 22.002 | 247199.996948242 |
| **2005** | 164579.4018824958 | 127.8305054194255 | 22.002 | 251279.998779297 |
| **2006** | 210456.7891942233 | 110.3653159164038 | 22.002 | 239559.997558594 |
| **2007** | 233832.3680647477 | 137.079019797075 | 62.339 | 230339.996337891 |
| **2008** | 262196.8422398828 | 125.4802831500881 | 84.341 | 236320.007324219 |
| **2009** | 277539.182259969 | 118.8857235839045 | 91.675 | 222729.995727539 |
| **2010** | 339305.9716474861 | 134.3499018311903 | 102.676 | 247550.003051758 |
| **2011** | 381562.3469963163 | 147.784640073268 | 84.341 | 258100.006103516 |
| **2012** | 425406.7660331857 | 154.1723140461756 | 128.345 | 261670.013427734 |
| **2013** | 463639.6849491132 | 140.3110169164573 | 117.344 | 275380.004882813 |
| **2014** | 502494.5875285658 | 142.1292220713263 | 121.011 | 285160.003662109 |
| **2015** | 517282.1523259351 | 0 | 124.678 | 279339.996337891 |
| **2016** | 543685.1995785101 | 0 | 121.011 | 289540.008544922 |
| **2017** | 593807.1335932704 | 0 | 0 | 293790.008544922 |
| **2018** | 650680.2465741525 | 0 | 0 | 299619.995117188 |
| **2019** | 716359.6728551379 | 0 | 0 | 308179.992675781 |
| **2020** | 740432.200448616 | 0 | 0 | 0 |
| **2021** | 825090.9572242905 | 0 | 0 | 0 |