CARBON EMISSIONS AND ECONOMIC GROWTH IN NIGERIA

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Abstract

This study tests the environemtal kuznet curve (EKC) hypothesis to find evidence of an inverted-U realtinship between carbon emissions and economic growth in Nigeria, from 1980-2016 Annual timeseries data was gotten from world development index (WDI). **There is an inverted U relationship or a turning point is reached when EKC hypothesis is accepted. The ekc is accepted if** ***there is a positive relationship between GDP and CO2 on the short run and a negative relationship between CO2 and GDP on the long run. The findings shows that Nigeria has not reached a turning point in its level of carbon emissions as economic growth increases. Nigeria is still at the initial stage of growth where carbon emissions accelerate as growth increases. There is need for policies that will broaden the use of renewable energy such as solar, wind energy as energy sources in meeting the energy needs of the fast growing population in Nigeria. There is need to ensure that imported vehicles into Nigeria must meet emission standards to reduce carbon emissions from road transportation. These policies will be instrumental in creating a turning point in carbon emission growth in Nigeria other wise higher carbon emissions will pose higher risk of future climate change impact in Nigeria and to the rest of the world.***

Keywords: CO_2, economic growth, EKC, urbanization, VECM

Introduction

Global warming is caused by the excessive accumulation of greenhouse gases (GHGs) in the atmostphere, the primary source of carbon combustion of fosil fuels for industrial, agricultural and transportation use. Carbondioxide is the most dominant of the GHGs in the atmostphere accouting for over 60% GHGs in the atmostphere, and is responsible for over 72% of the warming of the global atmosphere. Emissions from transport increased by 2% annually at the global level within the period 2000-2017, reaching 8GtCO2, and transport did not experience any major decrease across any regions, except for the drop during the years of the crisis, road transport accounts for three quarter of total transport emissions. Human economic activities in the last 50 years contributed so much to the increase in carbon emissions and the concentration of greenhouse gases in the atmosphere, obviously leading to the enhanced greenhouse effect, which in turn is going to lead to climate change (Adesina &Adejuwon, 2018). The impact of climate change on the environment has taken different forms over the years. Climate Change has led to a rise in temperature which causes a rise in the sea level from the thermal expansion of water. When there is a rise in the sea level it would cause an increase in coastal erosion, flooding, property damage, and loss of lives across the globe. An example of flooding that claimed lives of so many Nigerians and also caused the loss of properties is the flood which occured in 2012 where it claimed the lives and properties of many people in Adamawa, Taraba, Plateau, and Benue.

The fast growing urban population implies rapid growth in material demand to build infrastructure, expansion of industrial and agricultural production, and increased mobility of people and goods, boosting the energy demand. Thus, meeting the higher energy demands in Nigeria and developing countries will imply more carbon emissions and higher risk of future climate change impact.

The environmental Kuznets curve hypothesis is the theoretical framework that is widely applied to link economic growth to the degradation of the environment. According to the EKC hypothesis, as a country experiences increased income in its early years of development, the level degradation of the environment will also increase up to a maximum income level. Increasing economic growth beyond this income threshold will bring about a decline in the level of environmental degradation. This study will test the EKC hypothesis in Nigeria to investigate if Nigeria has reached a turning point in carbon emissions as higher growth is attained.

The rest of this paper is considered as follows. Section 2 is the literature. Section 3 presents the methodology while results are discussed in section 4. Conclusion and recommendation comes up in section 5.

Literature

Roca & Alcantara, (2018), in examining the link between growth and greenhouse gas emissions rejected the existence of the EKC in Spain from 2010 to 2015.

(Eric, 2019) had studied the interactions between welfare and environmental degradation and ended that environmental issues will threaten social well-being. (Christophe, 2015) showed that anticipation would increase up to twenty-two months if the most important European cities will scale back pollution.

(Chang, 2017) examined the linkage between energy use (coal) and economic growth within the BRICS countries in 1985-2009. The study found a unidirectional causality running from energy use to economic growth in China, and from economic growth to energy use in African countries. ANG (2007) applied a cointegration approach to examine the dynamic relationshipship between economic development, energy consumption and pollution. The study found a short-term unidirectional causality from energy use to economic growth.

Omisakin, (2009) tested the EKC hypothesis for CO2 with annual data of CO2 per capita and GDP per capita from 1970-2005. The study found no long-run relationship between carbon emissions per capita and income per capita in Nigeria. The result on the other hand, depicted a U-shaped income-environment relationship rather than an inverted U shaped contradicting the EKC hypothesis.

Bello & Abimbola, (2010) found no evidence of an inverted-U shaped relationship between income and the environment in Nigeria. The study applied time series data from 1980-2008 in Nigeria. The study concluded that carbon emission in Nigeria is not driven by economic growth but rather driven by financial developments such as foreign direct investment (FDI). This is because the study found that economic development do not have any influence on CO2 emissions in Nigeria.

Fodhaet, (2010) investigated the relationship between economic growth and the environmental degradation for a small developing country, Tunisia. The study used a time-series data from the period 1961-2004 with CO2 and SO2 as the environmental indicators and GDP as the economic indicator. The study results showed that there is a long run cointegration relationship between per capita GDP and the per capita emissions of the two pollutants (CO2 and SO2) but the relationship between CO2 emissions and GDP was found to be more monotonically increasing as compared to that between SO2 and GDP. The study further tested the causal relationship between income and pollution and found that, the relationship between the two in Tunisia is unidirectional both in the short and long run implying that, income causes environmental damages and not vice versa.

Methodology

Data

The study gathered annual time series data for metric tons of carbon emissions and gross domestic product (GDP), energy consumption and Urbanization from the World Development Index from 1980 to 2016. The carbon emissions will be used as a proxy for environmental degradation. All data will be converted in natural logarithms to bring all variables to the same unit of measurement to enhance the modelling and make the interpretation of coefficients easier.

Model Specification

$$\Delta lCO_{2,t} = \beta_0 + \beta_1 lCO_{2,t-1} + \beta_2 lGDP_{\ t-1} + \beta_3 Urb_{i,t} + \beta_{4ECONS_{t-1}+\sum_{i=1}^{P}\alpha_1 \Delta lGDP_{t-1}\ \Sigma_{i=1}^{q}\alpha_2 \Delta Urb_{t-1} + \Sigma_{i=0}^{r}\alpha_3 \Delta ECONS_{t-1} + \mu_t} \ldots\ldots 4$$

Where $\beta_1 - \beta_4$Represents the long-run parameter to be estimated. They tell the impact of $co_{2t-1}, GDP, URB\ and\ ECONS\ respectively\ on\ Co_{2t}$. $\propto_1 - \alpha_3$ –Short-run parameter to be estimated.

They show the short-run impact of $co_{2t-1}, GDP, URB\ and\ ECONS\ respectively\ on\ Co_{2t}$.

P, q,r - maximum lag length to be determined based on SIC lag selected criteria within a VAR framework; μ - Error term; β_1GDP – captures a linear relationship where the relationship is monotonically increasing or decreasing. If short-run income elasticity of GDP is positive and significant and long-run income elasticity is of GDP is negative and not significant then we can say the EKC theory holds or if the short-run income elasticity of GDP is larger than the long-run income elasticity of GDP

The data to be used for this analysis includes carbon emission (CAEM) energy consumption (ENC), gross domestic product (LNGDP) and urbanization (URBAN) for the period 1980-2016.

Figure 1: Timeseries plots

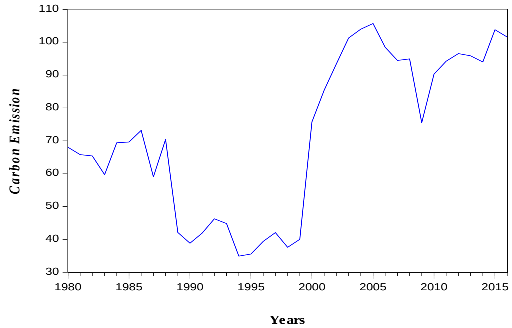

Figure 4.1 Trend for Carbon Emission in Nigeria from 1980-2016

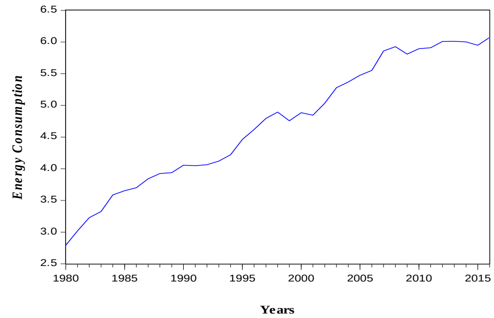

Figure 4.2: Trend for Energy Consumption in Nigeria from 1980-2016

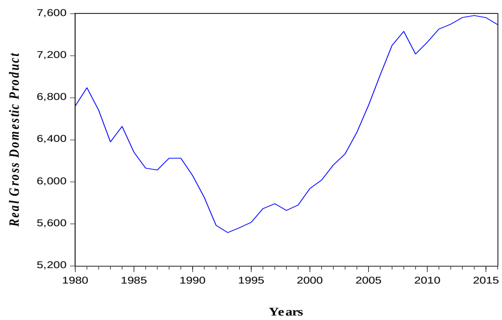

Figure 4.3: Trend for Real Gross Domestic Product in Nigeria from 1980-2016

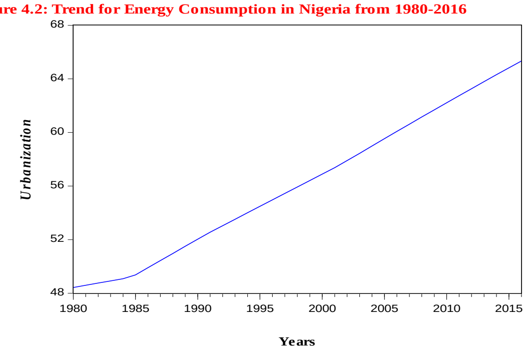

Figure 4.4: Trend for Urbanization in Nigeria from 1980-2016

Figure 1 is the plots of carbonemissions, energy consumption , GDP and Urbanization in Nigeria from 1980-2016. From the graph, there was a fluctuation in carbon emission from 1980-1986. The value of carbon emission increased from 1998 and got to its peak in the year 2005. The graph further depicts some fluctuations from 2005-2016. Figure 1 shows that energy consumption from 1980 has been on the increase. This implies that over the period under consideration, the consumption of energy never dropped. Gross domestic product is the monetary value of goods and services produced in an economy over a particular period. The Nigeria gross domestic product decreased from 1980-1992. Thereafter, it increased and never decreased below the 1980 value. Urbanization refers to the population shift from rural areas to urban areas, the gradual increase in the proportion of people living in urban areas. From the graph, urbanization had been on the increase.

Results

The empirical analysis was done with the use of econometrics views 9.0 (E-views 9.0) analytical software which was used to estimate the model and the following results were reflected in the subsequent sections

Table 1: Descriptive Statistics

	CAEM	ECONS	GDP	URBAN
Mean	71.61	4.73	6499.00	56.15
Median	70.42	4.79	6283.11	55.93
Maximum	105.71	6.07	7582.69	65.34
Minimum	34.93	2.79	5517.53	48.43

Std. Dev.	24.37	0.99	688.85	5.35
Skewness	-0.15	-0.16	0.29	0.12
Kurtosis	1.55	1.80	1.70	1.75

Source: Authors computation using E-Views 9.0

The descriptive statistics presented in Table 1 shows a 71.61 mean value for carbon emission with a maximum of 105.70 and minimum value of 34.93. The result also reveals that the dispersion of the carbon emission around the mean value is 71.60; this is an indication that the series sparingly spread around the mean, the carbon emission of the country over the examined year clustered around the mean. The skewness result of 0.08 which is less than the threshold of 0 means that carbon emission is negatively skewed, it implies that the carbon emission across the panel is scantily below the mean value; the series is approximately normally distributed; this is also reflected in the Kurtosis result which showed excess kurtosis of 1.55 being below the threshold of 3. This means that the series, carbon emission is platykurtic; it is an indication that the series are lowlily peaked, that is slightly below the normal distribution peak, this means that few of the carbon emission are above the mean value. The normality of the series was tested by skewness/kurtosis normality test; the null hypothesis of this test states that the series are normally distributed but the *p-value* of the test showing 0.185 per cent which is greater than the 5% significance level revealed that carbon emission is normally distributed.

The overall average of the energy consumption in Nigeria within the time frame of 37years is 4.728 while the least energy consumption reported is 2.794 with a maximum value of 6.073; the result of the measure of variation of 0.9993 which is a reflection of the series not widely deviated from the mean. The skewness result of -0.158 which is less than the threshold of 0 means that energy consumption is negatively skewed, it implies that many of the energy consumption across the periods are below the mean value; on the other side, the Kurtosis result which is 1.801 being above the threshold of 0 means that the series (energy consumption) is platykurtic and tending towards being mesokurtic with the peak lower than the peak of the normal distribution; this means that many of the energy consumption are not above the mean value. The result of the normality of the series being tested by skewness/kurtosis normality test showed *p-value* of 0.000 percent which is greater than the 5% significance level is an indication that energy consumption is normally distributed.

The mean value for gross domestic product is 6499.006 billion naira and this means that on the average, gross domestic product in Nigeria within the period under study is 6499.006 billion naira. Furthermore, the highest gross domestic product within the periods under consideration was 7582.697 billion naira while the lowest was 5517.53 billion naira. Standard deviation measures the dispersion of the series from the mean value, the result of standard deviation with 688.85 showed that the series (gross domestic product) are widely varied from the mean of 6499.006 billion naira. The skewness result of 0.289 being greater than the threshold of 0 means that gross domestic product is positively skewed, it implies that many of the gross domestic product within the periods are above the mean value; this is also reflected in the Kurtosis result which showed 1.70 being above the threshold of 0 means that the series (gross domestic product) is platykurtic, it is an indication that the series is not strongly peaked, that is sharply below the normal distribution peak; it is an indication that most of the gross domestic product is above the mean value. The normality result of the series as tested by skewness/kurtosis normality test with the null hypothesis which states that the series is normally distributed with the *p-value* of 0.209 per cent which is greater than the 5% significance level revealed that gross domestic product is not normally distributed.

As reflected in Table of descriptive statistics, the average value for urbanization in Nigeria is 56.15 with a maximum of 65.34 while the minimum value reported within the period covered by the study is 48.43. The result also reveals the dispersion of the urbanization around the mean value is 5.354, this is an indication that the series sparingly spread around the mean, the urbanization of the country over the examined year clustered around the mean. The skewness result of 0.115 which is greater than the threshold of 0 means that urbanization is positively skewed, it implies that the urbanization across the panel is scantily above the mean value; the series is approximately normally distributed; this is also reflected in the Kurtosis result showed excess kurtosis of 1.75 is below the threshold of 3 means that the series (urbanization is platykurtic; it is an indication that the series are lowlily peaked, that is slightly below the normal distribution peak, this means that few of the urbanization are above the mean value. The normality of the series was tested by skewness/kurtosis normality test; the null hypothesis of this test states that the series are normally distributed but the *p-value* of the test showing 0.288 per cent which is greater than the 5% significance level revealed that urbanization is normally distributed.

Unit Root Test

The analysis uses time series, as a result, the unit root test is needed to check for the stationary of the data. The variables used are carbon emission (CAEM) energy consumption (ENC), gross domestic product (LNGDP) and urbanization (URBAN). The unit root test is represented in the table below

Table 2: Augmented Dickey-Fuller Test Result

Series	ADF levels	ADF First Difference	Order of integration
CAEM	-0.953	-6.044***	I(1)
ECONS	-2.077	-5.289***	I(1)
LNGDP	-0.849	-3.601**	I(1)
URBAN	0.585	-3.481**	I(1)
Where *, **, *** represents statistical significance at 10%, 5% and 1% respectively			

Source: Authors computation

The Augmented Dickey Fuller (ADF) and Phillip Perron (PP) test reported in Table 2 and 3 respectively shows the results whereby all the variables, carbon emission, energy consumption, gross domestic product, and urbanization are all nonstationary but they become stationary at first difference.

Table 3: Phillip Perron Test Result

Series	ADF Test Difference	Order of integration
CAEM	-6.04***	I(1)
LNGDP	-5.28***	I(1)
ENCOM	-3.65***	I(1)
URBAN	-2.99**	I(1)
Where *, **, *** represents statistical significance at 10%, 5% and 1% respectively		

Since the ADF and PP unit root tests indicates more than 2 nonstationary variables, we apply the Johansen cointegration test to examine if the variables will become stationary if combined in a linear fashion. If this is true, then cointegration is said to exist and the variables are cointegrated. The Schwatz Information Criterion (SIC) was applied to determine the optimum lag length with in the VAR framework. The selected lag length is 2 lags. if the trace statistic and maximum Eigenvalue is greater than the critical value then the null hypothesis of no cointegration is rejected. Alternatively, if the trace statistic and maximum Eigenvalue is lower than the critical value then reject the null hypothesis.

Table 5: Tabular Representation of the Johansen Co-integration test Based on Trace Statistic

Null/no. ofcoingrating equations	Trace Statistic	0.05 Critical Value
None *	56.40**	47.85
"At most 1"	28.81**	29.79
"At most 2"	11.31	15.49
"At most 3"	1.167	3.84
	Eigenvalue	
Null/no. ofcoingrating equations	Max-Eigen Statistic	0.05 Critical Value
None *	27.59**	27.58
At most 1	17.50	21.13
At most 2	10.14	14.26
At most 3	1.17	3.84

The Johansen Cointegration result presented in Table 5 results show that there is at least one co-integration equations based on trace Statistic and Max Eigenvalue statistics. The Johansen co-integration result denotes that there is a long-run relationship among the variables based on trace statistics and Eigenvalue statistics. The alternative hypothesis is accepted. The existence of a long-run relationship will lead to a vector correction model (VCM) to also find out short-run and long-run dynamics.

Vector Correction Model Result

As stated above, the vector error correction model denotes a short-run relationship and also long-coefficients.

Table 6: VECM Result

Panel A: Short Run Estimates			
Variables	Coefficients	Standard Error	T-Statistics
ECONS	0.03	0.08	0.34
LNGDP	0.06	0.01	3.77*
URBAN	0.04	0.74	1.09
CointEq1	-0.31	0.14	2.19
Panel B: Long Run Estimates			
CAEM	1.000		
ECONS	-1.36	0.43	-3.12*
LNGDP	5.77	0.74	7.79*
URBAN	0.15	0.07	2.06*
C	48.55		
R^2	0.29		
Adj R sq	0.03		
F-statistics	1.10		
Panel C: Post Estimation			
Serial Correlation	1.30		
Heteroskedasticity	0.59		
Normality Test	0.26		

Where: ***, **, * represents statistical significance at 1%, 5%, and 10% significance level

The short and long-run estimates from the implementation of the VECM model is reported on panel A and B of Table 6. The result on Panel "A" shows that real gross domestic product has statistically significant positive short-run impact of 0.06% on carbon emission. This result implies that increase in economic growth in Nigeria increases carbon emissions and depletes the quality of the environment, while a decline in economic growth will reduce carbon emission in Nigeria by 0.06%. Similarly, Energy consumption and urbanization have a positive impact on carbon emissions in Nigeria. The result shows that a 1% increase (decrease) in energy consumption and urbanization will bring about a 0.03 and 0.04% increase (decrease) in carbon emissions respectively. Although this result is not statistically significant at least at 5%, the positive coefficients were expected. It implies that as urban population increases due to rural-urban migration in search of improved welfare, the energy consumption increases as a result of increase in human activites in transportation, production to meet increased demand, carbon emsission increases in turn which reduces the quality of the environment.

The regression result from Table 6 panel B shows a negative relationship between energy consumption and carbon emission in Nigeria. This implies that a unit increase in energy consumption will lead to 0.0135% decrease in carbon emission in Nigeria. This result implies that energy efficiency increased in the long run in Nigeria as higher growth is attained with less energy consumption. This could be as a result of increased investment in solar and renewable energy within the country. Most businesses have added solor energy to their energy mix , others are applying efficient devices that consumes less energy which has reduced energy consumption while growth increases. However, gross domestic product and urbanization have a positive effect on carbon emission in Nigeria. From the equation, a percentage increase in the gross domestic product will lead to 5.769% increase in carbon emission. Similarly, a unit increase in urbanization will lead to 0.0154% increase in carbon emission in Nigeria. The result in panel C indicates that the mode has no serial correlation, heteroschedasticity and the variables are normally distributed.

The R^2 indicates that 29.2% of the variations in carbon emissions are explained the model. This suggests there are other important variables that are capable of explaining the variations in carbone emissions. Future research may fill this gap. The Cusum graph, indicates that the model is stable.

Toda Yamamoto Causality Test

Toda Yamamoto causality test was implemented to examine the direction of causality between energy consumption, economic growth and carbon emissions in Nigeria. The result shows bidirectional causality between carbon emission and energy consumption. There is a unidirectional relationship from carbon emission to gross domestic product.

Conclusion

The study tested the environemental Kuznets curve hypothesis in Nigeria using annual data gathered from the World bank development indicators (WDI) from 1980-2016. The econometrics tool used in this study includes; Error Correction Model (ECM) and the Toda Yamamato Causality test which were used to determine the level of impact that one variable has on another as well as the direction of causality between them. The result arising from our findings indicates that economic growth, energy consumption and urbanization have a positive and statistically significant longrun and shortrun effect on carbon emissions in Nigeria. There is need for policies to achieve energy efficiency. Nigeria should bear in mind the need for a cleaner environment as higher growth is pursued. Clean energy such as renewable energy technology should be added to the energy mix of the country as the government tries to meet the energy needs of its fast growing population and for industry. Nigeria should put in place strong policies to control the importation of cars with poor emission standards and fine defaulters adequately in order to curtail carbon emissions from raod transportation.

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