ANALYSING THE VALIDITY OF THE ENVIRONMENTAL KUZNETS CURVE HYPOTHESIS ON EMISSION IN NIGERIA

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ABSTRACT

In spite of the level of income that has been attained in the developed economies, environmental challenge is still an issue affecting both developed and developing countries, and also one of the targets of global sustainable development goal is to reduce carbon dioxide emission (CO2) to zero (0%) by the year 2050. This study investigated the validity of the environmental Kuznets curve hypothesis on carbon dioxide emission (CO2) in Nigeria. The study adopted classical reduced cubic form of environmental Kuznets curve (EKC) model. Secondary data were sourced from the World Bank's World Development Indicator (WDI, 2024) from 1980 to 2023. The study employed correlation matrix, Autoregressive distribution lag (ARDL) bound test to analyze the data. The result of bound test showed that there is a long run relationship among the variables. The results of the short run estimates revealed that the three coefficients of income per capita are in line with the inverted U-shape of the Environmental Kuznets Curve (EKC) that requires the coefficients of income per capita (GDP/P) to be positive, the coefficient of income per square (GDP/P^2) to be negative and the coefficient of income per capita cubed (GDP/P^3) to be positive. The study therefore recommended that government should pursue sustainable growth policies that offer opportunities for rapid growth and sustained economic growth without detrimental effects on environmental quality.

Key Word: Environmental Kuznets Curve, Carbon dioxide emission, Per capita income, ARDL, Nigeria

1.0 INRODUCTION

The world is confronted right now with high climate change causes by carbon dioxide emission which leads to increasing global warming and emission of greenhouses. Nigeria faced with consequences such as; temperature increase, rainfall variability, it is also reflected drought, desertification, rising sea levels erosion, floods, thunderstorm, bush fires, landslides, land degradation, more frequent extreme weather conditions and loss of biodiversity. As such various aspect of our environment issues including validity of Environmental Kuznets curve (EKC) hypothesis have been among the trending issues of sustainable development goal.

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Nigeria as the biggest oil producer in Africa 13th largest oil producer in the world is the leading contributor in term of fuel processing and fuel consumption that causes sulphur dioxide (SO_2) emission, with rapid population growth, it is the leading cause of carbon dioxide (CO_2) emission in ECOWAS Countries and top 50 carbon dioxide (CO_2) emitters in the world (Omotor, 2017). With the growth in economic activities, most especially agricultural activities from 1960s to 70s, mining and crude oil exploration from 1970s to date and industrialization drive to economic development; the environmental quality has been compromised in Nigeria (Omotor, 2017). Constantini and martini (2006) argue that to achieve industrialization without extreme damaging the environmental quality is a challenge confronting the poor developing countries like Nigeria.

According to World Bank (2019), environmental quality may be affected by expanding residential, commercial and public services buildings coupled with the increased energy demand due to increasing consumption of gaseous, liquid and solid fuels by households and industries in the country. In addition environmental quality may be compromised by increase agricultural activities (discharges from fertilizer applications, fishing crops and animal waste burning of taming waste etc.);burning of fossil fuels (crude oil exploration petroleum refining, coal mining, and natural gas extraction). Furthermore upsurge in construction and manufacturing activities, electricity generation, gas flaring and other energy-producing activities are behind the increase in environmental pollutants in terms of increase in carbon dioxide (CO_2) emission, sulphur dioxide, nitrogen oxide, carbon monoxide, combustible renewable and waste (municipal waste, industrial waste, biogas liquid biomass, and solid biomass) and deforestation.

Environmental Kuznets Curve is about the long run relationship between the level of income per capita and different indicators of environmental quality. Simon Kuznet (1995) who observed that the relationship between economic growth and income inequality is an inverted U-shaped curve. This implies that an income increases, inequality increases up to a point where it begins to fall. Grossman and Krueger (1991) examine the relationship between three air pollutants of CO_2, SO_2 and smoke and the data from 42 countries. They observed that two out or the three pollutants increases at low income level and decreases at high national income level. The relationship between income growth and environment quality has the same shape as the Kuznets curve also Dinda 2004, costantini & martini, 2006, Jula etal, 2015, muniraml Khan 2014. Hence, the curve is named after Simon Kuznets as environmental Kuznets Curve, relating to environmental quality, rather than income Inequality, and as the environmental hypothesis. However, Environmental Kuznets curve can be viewed as a representation or the natural course of economic development from unpolluted agrarian economy to a polluting industrial economy, and lastly to an unpolluted service economy (Arrow etal 1995, as cited in Dinda, 2004). However, it has been argued that some challenges of the EKC are that it assumes the economy to be sustainable, where income is exogenous, which is not affected by the environmental pollutants and it has not been empirically documented that EKC is applicable to all environment degradation indicators (stern, 2003).

Carbon dioxide (CO_2) emission per capita can increase with presence of heavy industries in cities. It has been maintained that consumption of goods and services by inviduals and household is the dominant

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cause of global warning due to the utilization of resources in the fabrication, distribution, sale and use of goods and services (satterthwaite, 2009). Globally, increase in CO_2 emission has been a concern (Adusah-Poku,2016). Adu and Denkyirah (2017) claimed that the main driver of carbon (CO_2) dioxide emissions is increase in economic development. Although, there previous studies that investigates the Environmental Kuznets Curve (EKC) hypothesis, however, most of the studies use simple linear equation in both variables and parameters. The study of Ayadi (2020), which use data from 1980 to 2007 in Nigeria, finds result contrary to the EKC hypothesis. Akpan and Chuku (2021), who used autoregressive distributed lag (ARDL) approach to examined the environmental kuznets curve in Nigeria with time series data from 1960 to 2008 and that of Ominyina and Abu (2017), which employed data from 1986 to 2015 found evidence of EKC hypothesis.

The present study uses exponential function of income per capita (GDP/P^3) in the models of EKC for Nigeria. The study also proxy carbon dioxide emission by carbon dioxide intensity to see the effect of carbon dioxide intensity on income per capita in addition to estimation of the population growth trade openness in the standard of EKC model that have impact on environmental degradation and income per capita in the country. It also checks whether or not environmental pollution has decline with the increasing level of income in Nigeria for period 1980 to 2023.

2.0 LITERATURE REVIEW AND THEORETICAL FRAME WORK

2.1 Theoretical Literature

Analytically, the environmental Kuznets curve (EKC) is employed to estimate the relationship between pollution and income per capita. The leading critiques of the EKC have argued that the econometric framework of EKC is subjective (Arrow et al., 1995; Copeland & Taylor, 2004; Stern, 1998). Dasgupta (2002) argued that EKC is monotonic. There are two perspectives to this argument namely new toxics and race-to-the-bottom scenarios. The new toxics scenario posits that EKC does not hold for new toxics e.g., carcinogenic chemicals, and carbon dioxide. On the other hand, the race to the bottom scenario asserts that EKC is inconsistent because of the outsourcing operation by developed countries in which they outsource dirty production to developing countries thereby making it increasingly difficult for emissions to be reduced. The revised EKC further argued that arising from inevitable technological changes, EKC shows a downward curve behavior shifting to the left (Stern, 2004). Stern (2004) contends that the proximate causes that define the EKC relationship are namely, the scale effect (expansion), the changes in economic structure or product mix, changes in the technological state, different industrial pollution, and changes in input mix.

In a similar vein, scholars try to decompose pollution, a major issue in the EKCs. Selden and Song (1994) estimated EKCs using four-dimensional series namely SO_2, NOx, SPM, and CO_2. Shafik and Bandyopadhyay (1992) studied EKC from 10 indicators. Grossman and Krueger (1991) estimated EKCs using SO_2, dark matter (fine smoke), and suspended particles (SPM). In a related development, pollution was decomposed into local pollution and global pollution in the study of EKC (Lopez, 1994). According

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to Lopez (1994), local pollution is amenable to EKC rather than global pollution. Also, pollution generated from consumption rather than production was considered in a study such as McConnel (1997).

Empirically, the EKC is conceptualized in the literature from two generations of analysis. Firstly, first-generation EKC (FGEKC) conceptualized a two-phased dimension: increasing and decreasing functional relationship between income inequality and economic development expansion over time (Kuznets, 1955). Secondly, FGEKC estimated that income inequality first rises and then falls as economies develop. In the second generation, the concept of EKC (SGEKC) further hypothesized a two-dimensional relationship between pollution events and economic growth per capita (Grossman & Krueger, 1991; Shafik & Bandyopadhyay, 1992). The apparent difference between FGEKC and SGEKC is the attention placed on income inequality (FGEKC) and GDP per capita (SGEKC). The underpinning argument anchored in both FGEKC and SGEKC is that pollution is sub-specie of development. Based on development realities, EKC argued that greater economic activity constitutes a task to environmental quality through technology-pollution channels. The SGEKC, therefore, views the scale effect as the core explanatory variable on the relationship between environmental pollution and income per capita. Within the SGEKC, two methodological frontiers exist that decomposed the two-dimensional EKC into a square-EKC model and a cubic-EKC model. The SGEKC model estimated a functional relationship between environmental pollution and quadratic (or cubic) GDP per capita.

2.2 Empirical Literature

Dauda (2018) examined the link between carbon dioxide (CO_2) emissions and income in Nigeria from 1971 to 2014 using annual time series data. The study analysed johansen cointegration test, vector error correction model (VECM) and VAR Granger causality test. The result revealed that there is evidence of long run equilibrium relationship amongs income per capita, carbon dioxide (CO_2) emissions, energy use, electricity power consumption, fossil fuel energy consumption in the country. It also revealed a unidirectional causality from carbon dioxide (CO_2) emissions to per capita income at 10% level of significance. However, the study did not consider per capita squared and income per capita cubed. Hence, the classical reduced cubic form of EKC model was not considered.

Lapinskiene, Tvaranaviciene and Valtkus (2013) tested the carbon emission, climate change and environmental kuznet curve (EKC) relationship between greenhouse gases (GHG) and per capita income in the Baltic countries using pooled cross sectional data from 1995 to 2008. The result confirms the presence of inverted U shape; the study recommended that policymaker, academics, and institutions to determine the future and consult to assist carbon emission control policies and future carbon reduction targets.

Alege and Ogundipe (2013) studied the relationship environmental quality and economic growth in Nigeria from 1970 to 2011. They used fractional co-integration analysis approach. They used a cubic equation model which contains CO_2 emission as proxy for environmental quality, while GDP, openness to trade, institutional quality, and population density are the explanatory variables. The result could not

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find any support for the EKC in Nigeria. However, the result revealed that weak institution and trade openness and high population density accentuate environmental degradation. The study recommends that policies drivers should embark on policies that restrict importation of carbon intensive products and check the activities of multi-national companies producing carbon intensive goods in poor country. Similarly, institutions needs to be strengthened to ensure appropriate abatement measures and adoption of cleaner technologies in order to mitigate the early rising of emission associated with early stage.

Egbetokun, Osabuohien, and Akinbobola (2018) examined the role of institution in the income –pollution relationship in attaining turning point in the North and Southern African countries. The study used three measures of air quality, CO_2, SO_2 and suspended particulate matter (SPM) and the Generalized Method of Moment to ascertain the role of institution in attaining turning point of the EKC .the result indicated that the two regions did not attain the level of income per capita capable of turning the EKC around for CO_2 and SO_2, but not for SPM. They concluded institutional quality should be strengthened in the two regions

Asante (2016) investigated the relationship between, CO_2 emission, economic growth, energy used and openness to trade in Ghana fromn1980 to 2011 using Johansen cointegration test, error correction model (ECM) and granger causality. The result from the cointegration test indicates a long run relationship among the variable. Granger causality test showed a unidirectional causality from economic growth to energy consumption. In addition, the result revealed that environmental Kuznets curve (EKC) is along run phenomenon, where at the initial phase; economic growths causes an increase in carbon emissions (CO_2) beyond a certain turning point, and thereafter continue increase in economic growth leads to decline in carbon dioxide emissions. However, this study was conducted in Ghana and the economic situation is not the same with Nigerian situation.

Omotor (2016) examined the relationship between per capita income and environmental degradation in the ECOWAS countries using two indicators of environmental quality of CO_2 and SO_2 emission. The results from both the fixed and random effect models support the existence of the Environmental Kuznets Curve in the ECOWAS region for both CO_2 and SO_2

Akpan and Chuku (2011) used autoregrasive distributed lag (ARDL) approach to examine the environmental Kuznets curve in Nigeria with the time series data from 1960 to 2008. The results found existence of long run relationship among income per capita, environmental interest. Nevertheless, there was no evidence of the EKC hypothesis as depicted by the inverse N-shape relationship between income per capita and environmental degradation in the country. However the study only concentrated on only two variables – GDP per capita and CO_2 – without taking into account the classical reduced cubic form of EKC model.

2.3 Theoretical Framework

The underpinning argument anchored in both FGEKC and SGEKC is that pollution is sub-specie of development. Based on development realities, EKC argued that greater economic activity constitutes a

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task to environmental quality through technology-pollution channels. The SGEKC, therefore, views the scale effect as the core explanatory variable on the relationship between environmental pollution and income per capita. Within the SGEKC, two methodological frontiers exist that decomposed the two-dimensional EKC into a square-EKC model and a cubic-EKC model. The SGEKC model estimated a functional relationship between environmental pollution and quadratic (or cubic) GDP per capita.

3.0 METHODOLOGY

3.1 Research Design

Data were sourced from World Development Indicators (WDI,2024). This study adopts a quasi-experimental research design. ARDL method was utilized to account for time varying Impact of carbon dioxide emission (proxy by CO_2 emission) on Environmental Kuznets Curve (EKC) in Nigeria. The annual time series data on carbon dioxide (CO_2) emission per capita, income proxy by per capita gross domestic product (GDP_P), Population growth (POPG) and trade openness (TRO).

3.2 Model Specification

Interest in Environmental Kuznets Curve (EKC) started with the pioneering studies of Grossman and Krueger (1991). The EKC captures the relationship between economic growth and environmental degradation. Standard EKC model uses quadratic function of income level. The standard EKC estimates there relationship between income level and the environment using any of the four environmental variables of carbon dioxide per capita emission, nitrous oxide emission, annual mean temperature, and annual mean rainfall. The model specification assumes that environmental pollution is a steady function of income level and square income level.

There is a general believe that international trade has significant effect on the environment. The pessimist opine that international trade depletes natural resources, raise the emission of CO_2 and cause more environmental degradation (Copland & Taylor,2001; Chaudhuri & Pfaff,2002) . To capture this concern, trade openness is added to the standard model. Different studies have demonstrated the importance of technology to the inverted U curve. For example, Andreoni and Levinson (2001) pointed that the inverse U-shape relationship between income and environmental degradation depends on technological level. The observed inverted U-shape relationship in the EKC is a result of convergence to sustainable growth path when technology is taken into consideration. Following the various regression model of Environmental Kuznet Curve (EKC), which test the relationship between environmental degradation and income, used in different studies; Stern (2003) the standard EKC regression model is specified in equation 1

$$\text{Ln}(E/P)_t = \beta_0 + \beta_1 \ln(GDP/P)_t + \beta_2 (\ln GDP/P)^2 + \epsilon_t \quad (1)$$

Where E denotes emissions, GDP/P is per capita income, p is population

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However, According to Costantini and Martini (2006) the reduced form equation of EKC has the advantage of giving the net effect of a country's income on environmental pollution. Thus, the classical reduced cubic form of EKC is the most preferable as presented below

$$E_t = \beta_0 + \beta_1 GDP_t + \beta_2 GDP^2 + \beta_3 GDP^3 + \epsilon_t \quad (2)$$

Where E is the environmental degradation indicator, other variables are as earlier defined above. By introducing the dependent variable of carbon dioxide.

$$CO2 = \beta_0 + \beta_1 GDP_t + \beta_2 GDP/P^2 + \beta_3 GDP/P^3 + \epsilon_t \quad (3)$$

According to Costantini and Martini (2006), the inverted U-shaped of the Environmental Kuznets Curve (EKC) from the equation 2 and 3 require β_1 to be positive and β_2 to be negative and β_3 to be positive. The turning point (TP) of the EKC from the expression model that, $\beta_1 > 0$, $\beta_2 < 0$ and, $\beta_3 = 0$. This is arrived at

$$X^* = -\frac{\boldsymbol{\beta 1}}{\boldsymbol{2\beta 2}}$$

This means an inverted U-Shaped relationship between economic growth/carbon dioxides depicting the Enviromental Kuznet Curve (EKC). Thus, following Dinda (2004), Chuang (2013), Shahbaz eta'l (2015), Adusah (2016), Omotor (2017) the estimated time series model is specified as follows

$$CO2t = \beta 0 + \beta_1 GDP/P + \beta_2 GDP/P2 + \beta_3 GDP/P3 + \beta_4 TRO + \beta_5 TECH + \epsilon \quad (4)$$

To take care of the endogeneity in the model, the study includes the lag of the dependent variable as exogenous variable see below;

$$CO2t = \beta 0 + \beta_1 CO2t\text{-}1 + \beta_2 GDP/P + \beta_3 GDP/P2 + \beta_4 GDP/P3 + \beta_5 TRO + \beta_6 TECH + \epsilon \quad (5)$$

3.3 Measurement of Variables

Trade openness (TRO) proxy by trade in service (% of GDP): Trade in service is the sum of service exports and imports divided by the value of GDP all in current U.S dollars.

Gross fixed capital formation (current LCU) Gross fixed capital formation includes land improvements (fences, drains, ditches, and so on); plant, machinery, and equipment purchases, and construction of road, railways, schools, offices, hospitals, and commercial industrial buildings.

CO_2 emissions (kt) Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.

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Gross domestic product per capita (current LCU) GDP per capita is gross domestic product divided by midyer population. GDP is the sum of gross value added by all the resident producers and minus any subsidies not included in the value of the product.

Population in the largest city: (% of urban population in largest city is the percentage of a country's urban population living in that country's largest metropolitan area.

3.4 Estimation Techniques The study adopts the Auto-Regressive Distributed Lag (ARDL) econometrics regression techniques to developed by Pesaran, Shin and Smith (2001) to analyze the data. The independent variables GDP,GDP_P2,GDP_P3 TRO,POPG and TECH were regressed on the dependent variable CO_2 Emission.

i. Unit Root Test Maddala (2007) observed that time series data are fraught with unit root. Ignoring unit root and running regression with the data will lead to spurious regression (Granger& Newbold, 1974).therefore; it is advisable in empirical studies to examine the unit root properties of the data before applying them in regression analysis. The unit root test adopted in the study is the Augmented Dickey-Fuller approach.(Dickey &Fuller,1987).

Autoregressive Distributed Lag (ARDL) Approach

Since this study is using Autoregessive Distributed lag (ARDL) bounds testing method to cointegration test, the unrestricted/unconstrained empirical model is as follows

$$CO2_t = \beta_0 + \beta_1 GDP/P_{t-1} + \beta_2 TGDP/P2_{t-1} + \beta_3 GDP/P3_{t-1} + \beta_4 TRO_{t-1} + \beta GFCF_{5t-1} + \beta_6 POPG_{t-1} + \sum_{i=1}^{P} \alpha_{1i} \Delta CO2_{t-1} + \sum_{i=0}^{P} \alpha_{2i} \Delta GDP/P_{t-1} + \sum_{i=0}^{P} \alpha_{3i} \Delta GDP/P2_{t-1} + \sum_{i=0}^{P} \alpha_{4i} \Delta GDP/P3_{t-1} + \sum_{i=0}^{P} \alpha_{5i} \Delta TRO_{t-} + \sum_{i=0}^{P} \alpha_{6i} \Delta GFCF_{t-11} + \sum_{i=0}^{P} \alpha_{7i} \Delta POPG_{t-1} + \sum_{i=0}^{P} \alpha_{8i} + \mu_t \quad (6)$$

Where:
CO_2 = carbon dioxide emission
GDP/P= Gross domestic product per capita
TRO = Trade openness (proxy by trade service)
GFCF= Gross fixed capital formation (technological progress)
POPG = Population growth.

The null hypothesis of no cointegration of the ARDL model is Ho: $\beta_1,\beta_2, \beta_3,\beta_4,\beta_5 = 0$ denoting no cointegration While the alternative hypothesis of the ARDL cointegration among the variables is H1= $\beta_1,\beta_2, \beta_3,\beta_4,\beta_5 = 0$, implying presence of cointegration. To confirm the existence or otherwise of cointegration (long run equilibrium) relationships among the variables, the F-test statistics calculated is

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compared with the critical value which comprises of lower critical bound and upper critical bound value of Pesaran et al. (2001).

4.0 RESULTS AND DISCUSSION

This section presents and discussed the empirical results of the data analysis. The data collected for the study was analyzed with the aid of E-view 10. The results are presented and discussed below.

Table 1: Correlation Matrix Result

	CO2IN	CO2IN_1	GDP_P	GDP_P2	GDP_P3	TRO	GFCF	POPG
CO2IN	1.000							
CO2IN_1	0.768	1.000						
GDP_P	-0.490	-0.657	1.000					
GDP_P2	0.147	0.205	-0.354	1.000				
GDP_P3	-0.301	-0.462	0.826	-0.561	1.000			
TRO	-0.334	-0.366	0.2073	-0.082	0.238	1.000		
GFCF	0.263	0.136	0.154	-0.371	0.186	-0.204	1.000	
POPG	-0.464	-0.410	0.043	0.1709	-0.219	-0.049	-0.289	1.000

Source: Author's Computations Using E-View

From the result in table 1, the correlation matrix shows none of the pair- wise correlation coefficient is greater than 0.76. Hence, there is no reason to suspect the problem of multicolinearity among the variables. The variables can, therefore, be combined in a multiple regression model. However, the coefficient of GDP_P negative correlated to CO2IN; the coefficient of GDP_P2 is positve while the coefficient of GDP_P3 is negatively correlated to CO2IN as contrary to apriori expectation. This result is in contrary with the work of Dauda (2019) but inline to the result obtained by Johnson (2019), Akpan and Chukwu (2011). Perhaps, the outcome of the result in table 1 which is contrary to the apriori expectation may be that Nigeria situation CO2 may not translate EKC pattern.

4.2 ADF Unit Root Table

This test is conducted using Augmented Dickey-Fuller unit root test. The test is applied for this study so as not to run into nonsense regression, as spurious regression can lead one to misleading results.

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Table 2 ADF Unit Root Test

ADF TEST STATISTICS			CRITICAL VALUE AT 5% LEVEL OF SIGNIFICANCE		
VARIABLES	**Level**	**Ist Difference**	**Level**	**Ist Difference**	**Order of Inegration**
CO_2IN	-1.46482	-9.931453	-2.933158	-2.933158	I(1)
GDP_P	-3.523807	----------	-2.936942	----------	I(0)
GDP_P2	-5.282799	----------	-2.933158	----------	I(0)
GDP_P3	-5.140311	----------	-2.933158	----------	I(0)
GFCF	-0.999625	-9.079264	-2.936942	-2.936942	I(1)
POPG	-6.797467	----------	-2.951125	----------	I(0)
TRO	-3.331132	----------	-2.938987	----------	I(0)

Source: Author's Computation using E-view 10; 2023

From table 2 testing the stationarity of the variable at 5% level of significance, the ADF test result showed that GDP per capita,(GDP_P), GDP per squared (GDP_P2), GDP per cubed (GDP_P3), Population growth (POPG), Trade openness (TRO) are stationary at level while, Carbon dioxide emission (CO_2),Gross fixed capital formation(GFCF) were not stationary at level but all attained stationarity at 1st difference. This means that four (4) variable are integrated of order zero I (0) and two (2) of the remaining variables are integrated of order one I (1)).

Table 3: ARDL/Bound Test Co-integration

Test Statistic	**Value**	**K**
F-statistic	6.117941	6
Critical Value Bounds		
Significance	**I0 Bound**	**I1 Bound**
10%	1.99	2.94
5%	2.55	3.61
2.5%	2.55	3.61
1%	2.88	3.99

Source: Author's Computations Using E-View

From table 3, the empirical result of bound test cointegration shows that, F-statistics (6.117941) is greater than critical value of lower bound test (0) and also greater than upper bound test I(1) at 5% level of significance. This shows that there is a long run relationship among CO2IN, GDP per capita,(GDP_P),

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GDP per squared (GDP_P2), GDP per cubed (GDP_P3), Population growth (POPG) and Trade openness (TRO).

Table 4: Long Run Estimate

Variable	Coefficient	Std. Error	t-Statistic	Prob.
GDP_P	-25115.129656	15571.179307	-1.612924	0.1677
GDP_P2	340.517423	891.279504	0.382055	0.7181
GDP_P3	-100.525614	157.668223	-0.637577	0.5518
TRO	14632.284972	12897.632363	1.134494	0.0308
GFCF	5409.150891	3180.360463	1.700798	0.0149
POPG	90290.422246	336536.024366	0.268293	0.7992
C	-201581.071874	804637.277639	-0.250524	0.8122

Source: Author's Computations Using E-View

Using ARDL (2, 0, 0, 0, and 0) model atomically selected based on Akaike Information Criterion (AIC), results obtained are presented below. The estimated coefficients show long run elasticity of the variables.

In table 4, long run coefficient of GDP_P, GDP_P2 and GDP_P3 are not significant at 5% level. The sign of GDP_P,GDP_P2,GDP_P3 is contrary with the a priori expectation also not significant at 5% level. Perhaps this may be as result climate change variability which is low in the past compare to the period the study was carried out. Trade openness (TRO) is significant and positive at 1%, 5% and 10% level this means that 1% increase in TRO import and export increases economic progress causes huge drop in carbon dioxide emission (CO2) proxy by carbon dioxide intensity (CO2INS) by 14%. The coefficient of gross fixed capital formation (GFCF) is positive at 5% level, this means that for every 1% increase in technological progress carbon dioxide intensity (CO2IN) will reduce by 54% in Nigeria. This result is inline the findings of Asante (2011), Janathan (2023) but contrary with the findings of Akpan and Chukwu(2011).

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Table 5 ARDL short run Results

Table 5 ECM Results

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CO2INS(-1)	-0.029829	0.324433	-0.091941	0.9303
GDP_P(-1)	4744.841	2365.759	2.005631	0.1012
GDP_P2(-1)	-64.33179	154.7164	-0.415805	0.6948
GDP_P3(-1)	18.99166	17.27243	1.099536	0.3216
TRO(-1)	-2764.384	1073.111	2.576047	0.0497
GFCF(-1)	-1021.916	668.3007	-1.529127	0.0186
POPG(-1)	17057.99	76540.59	-0.222862	0.8325
C	38083.43	180397.8	0.211108	0.8411
R-squared	0.972099	Mean dependent var	0.003748	
Adjusted R-squared	0.922001	S.D. dependent var	0.211379	
S.E. of regression	0.114953	Akaike info criterion	-1.442147	
Sum squared resid	0.528564	Schwarz criterion	-1.35940	
Log likelihood	32.28508	Hannan-Quinn criter	- 1.411817	
F-statistic	98.63375	Durbin-Watson stat	1.794776	
Prob(F-statistic)	0.000000			

Source: Author's Computations Using E-View

From table 4, the results of the short run estimates reveal that though the three coefficient of income per capita is in line with the apriopri expectations having satisfied the inverted U-shape of the Environmental Kuznets Curve (EKC) that requires the coefficients of income per capita (GDP/P) to be positive, the coefficient of income per square (GDP/P^2) to be negative and the coefficient of income per capita cubed (GDP/P^3) to be positive.

Similarly, the coefficient of trade openness (TRO) and gross fixed capital formation (GFCF) are positive which is in line with the apriori expectation while population growth rate (POPG) is also positive, which points that increase in population growth rate will lead to increase in residential, commercial and public services buildings; increase commercial/institutional, agriculture/forestry, and fishing activities. Upsurge in manufacturing industries, construction, combustion, electricity/power generation and heat plants, coal mining, crude oil exploration and petroleum refineries/ oil and gas extraction, manufacturing of solid

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fuels, and consequently increase in energy demand leading to more consumption of gaseous/solid/liquid/fuel consumption by households and industries, increase in automobile that tend to heighten the over-exploitation of the ecosystem with deteriorating effect on the environmental quality in general and carbon dioxide (CO_2) in particular.

In order words, despite the fact that the three coefficients of income of income per capita devising the desired effect on carbon dioxide emissions as postulated by EKC hypothesis, they are found statistically not significance in influencing changes on carbon dioxide (CO_2) emission in Nigeria for the period under study. However the coefficient of R^2 is 0.972099 which shows that about 97% of the endogenous variable has been explained by the exogenous variable coefficient. This result is contrary to the study conducted by Adu and Denkyirah (2017) whose result indicated non-existence of inverted U-shape but in line with the results of Dauda 2014 whose result shows the existence of inverted U-shape in Nigeria.

Ta ble 5: Heteroskedasticity

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	0.471825	Prob. F(33,5)	0.9123
Obs*R-squared	29.52028	Prob. Chi-Square(33)	0.6411
Scaled explained SS	0.447121	Prob. Chi-Square(33)	1.0000

Source: Author's Computations Using E-View 10

The result of the Breusch-pagan-Godfrey test of heteroskedasticity is presented in table 5. The result also supports the acceptance of the null hypothesis. The BPG LM statistics (Obs*R-squared) is 29.52028 the probability of this value, the prob. Chi-square (33) is 0.6411 which is far greater than 0.05 critical value. Thus the null hypothesis is maintained at 0.05% level. It implies that the variances of the error term are constant: there is no evidence of heteroskedasticity in the error term

Table 6 Diagnostic Model Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	4.625715	Prob. F(2,3)	0.1212
Obs*R-squared	29.45009	Prob. Chi-Square(2)	0.3120

Source: Author's Computations Using E-View 10

The result of Breuch-Godfrey (BG) autocorrelation test result presented in table 7 above shows that there is no evidence of autocorrelation in the estimated error terms. The BG LM statistics value Obs*R-squared is 29.45009 the P- Value is greater than 0.05. Hence, the null hypothesis is maintained at 0.05 levels. Therefore this implies that there is no evidence to suspect autocorrelation in the error term.

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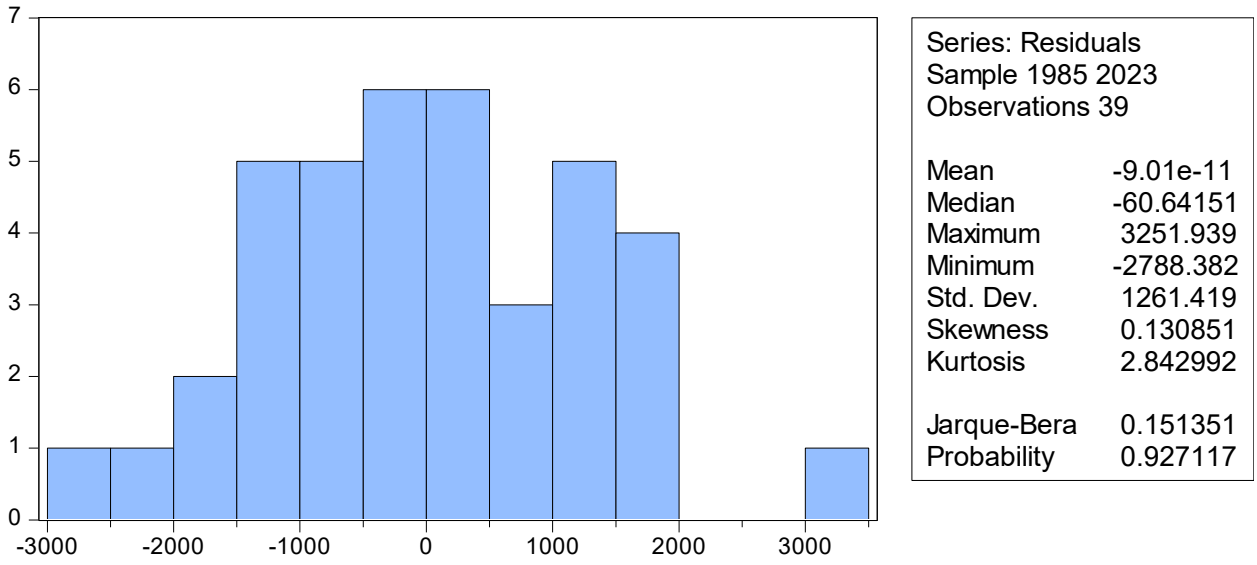

Fig 1: Normality test result

Source: Authur's computation from E-View 10

The Jaque-Bera test normality result figure 1 above revealed that the distribution of the residuals is normal. The JB statistics is 0.151351 with probability value of 0.927117. Therefore, the null hypothesis of normal distribution is maintained at 0.05% level.

5.1 Summary of Result

From table 1 the correlation matrix shows the correlation matrix shows none of the pair- wise correlation coefficient is greater than 0.90. Hence, there is no reason to suspect the problem of multicolinearity among the variables. The variables can, therefore, be combined in a multiple regression model. Similarly, the coefficient of trade openness (TRO) and gross fixed capital formation (GFCF) are positive which is in line with the apriori expectation while population growth rate (POPG) is also positive which is contrary to the apriori expectation. However, the coefficient of GDP_P is positively correlated to CO_2; the coefficient of GDP_P2 is negative while the coefficient of GDP_P3 is positively correlated to CO_2 as expected to apriori expectation. , the results of the short run estimates reveal that though the three coefficient of income per capita is in line with the apriopri expectations having satisfied the inverted U-shape of the Environmental Kuznets Curve (EKC) that requires the coefficients of income per capita (GDP/P) to be positive, the coefficient of income per square (GDP/P^2) to be negative and the coefficient of income per capita cubed (GDP/P^3) to be positive.

5.2 Conclusion

This study examines the validity of environmental Kuznets Curve (EKC) hypothesis in Nigeria from 1980 to 2023, using annual time series data sourced from World Development World Indicator of World Bank. Autoregressive Distributed Lag (ARDL) bounds testing method to cointegration is used to analyze the data. The study reveals that since Environmental Kuznets Curve (EKC) is about the long run relationship between the levels of income per capita and different indicators of environmental quality, there is no

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evidence of the existence of long run equilibrium relationship among carbon dioxide (CO_2) emissions income, population growth and trade openness in Nigeria from 1980 to 2023. Although in the short run, income per capita (GDP/P), income per capita squared (GDP/P^2), and income per capita cubed (GDP/P^3) have satisfied the inverted U-shaped of the Environmental Kuznets Curve (EKC) hypothesis, but they are not statistically significant in influencing changes in carbon dioxide (CO_2) emissions at 5% level of significance. It is recommended that government should pursue sustainable growth policies that offer opportunities for rapid growth and sustained economic growth without detrimental effects on the environmental quality.

Recommendations

There is need for government to embark on policies that restrict importation of carbon intensive products and check the activities of multinational companies producing carbon intensive goods in poor country. similarly institutions need to be strengthened to ensure appropriate abatement measures and adoption of cleaner technologies in order to mitigates rising emissions associated with the early development stages. The study also recommended

that urther studies should pay attention to the effect of increasing level of urbanization, Agriculture activities and fossil fuels in exploring the EKC hypothesis in Nigeria. Based on Stern (2003), it is also recommended that further studies should capture the local environmental pollutants in Nigeria such as deforestations, combustible renewable and waste to determine whether that can make significant difference from the result of previous studies.

REFERENCES

Adusah-Poku, F. (2016). Carbon dioxide emissions, urbanization and population: Empirical evidence in Sub Saharan Africa. *Journal of Energy Economics Letters, 3(1):1-16*

Akpan, U. F , & Chuku, A (2011). Economic growth and environmental degradation in Nigeria. Beyoung the Environmental Kuznets Curve. MPRA Paper No.31241Retrieved on 20th May, 2019.

Alege P. O , A. A. Ogundipe(2013). Environmental quality and economic growth in Nigeria: A fractional cointegration analysis.*International Journal of Development and Sustainability, 2(2),580-596*

Andreoni J, & A . Levinson(2001).The Simple Analytics of the Environmental Kuznets Curve. *Journal of Public Economics. ;80:269–286.*

Apergis, N.(2016).Environmental Kuznets curves: New evidence on both panel and country-level CO2 emissions. Energy Economics,54(3), 263-271.

@A Publication of the Department of Economics, ADSU, Mubi. ISSN- Print: 2550- 7869; ISSN-Online: 3043-5323. Journal homepage: https://ajaefm.adsu.edu.ng

Asante, K. (2016).Evidence of the Environmental Kuznets Curve Hypothesis in Ghana.An Independent Research Paper submitted to the faculty of KAIST in partial fulfilment of the requirements for the KOICA-KAIST Scholarship Program

Ayadi, F.S (2010). An empirical investigation of environmental Kuznets curve in Nigeria, *international journal of Green computing, 1(2):31-39.*

Bello, A.K. & Abimbola, O.M. (2010). Does the Level of Economic Growth Influence Environmental Quality in Nigeria: A Test of Environmental Kuznets Curve (EKC) Hypothesis?*Pakistan Journal of Social Sciences, 7(4) 325-329.*

Chaudhuri, Subham and Alexander Pfaff.1998. *Household Income, Fuel Choice, and Indoor Air Quality: Microfoundations of an Environmental Kuznets Curve*" mimeo, Columbia University Economics Department.

Chuang, A.D. (2013) effect of climate change on agriculcural productivity in Nigeria *European journal of sustainanable development research 7 (1): 2542-4742*

Copeland B.R. & M.S. Taylor (2004). Trade, Growth, and the Environment, *Journal of Economic Literature 42(1), 7-71.*

Costantini,V., & Martini, C (2010). Amodified environmental Kuznets curve for sustainable development assessment using panel Ltd. *International journal of Global Environmental issue, 10(1-2), 84-122.*

Dauda, M. I (2018) Relationship between Carbon Dioxide Emission and Income in Nigeria (1971-2014). *The Journal of Economics and Finance,2(1),20-36.*

Dickey, D. A., Fuller, W. A. (1979). Distribution of the Estimators for Autoregressive Time Series with a Unit Root.*Journal of the American Stat. Association, 74, 427–431*

Dinda, S (2004), Environmental Kuznet Curve hypothesis: *A survey Ecological Economics (49), 431-455*

Granger, C. W. J., and Newbold, P. (1974).Spurious Regressions in Econometrics. *Journal of Econometrics, 2, 111-120.*

Grossman, Gene M., and Alan B. Krueger.(1991). Environmental Impact of a North American Free Trade Agreement.Working Paper 3914.National Bureau of Economic Research, Cambridge, MA

Guterres, A. (2020*). UN chief warns of risk of famine for millions around the world. AFP.* https://www.france24.com/en/live-news/20210311-un-chief-warns-of-risk-of-famine-for-millions-around-the-world

IPCC. (2014). *Climate change: Impacts, adaptation, and vulnerability. IPCC. https://www.ipcc.ch/report/ar6/wg2/*

IPCC. (2015). *AR5 synthesis report-climate change 2014*. https://www.ipcc.ch/report/ar5/syr/

Johansen, S (1988). Statistical Analysis of Cointegration Vectors. *Journal of Economic Dynamics and Control, 12, 23-1.54*

Johansen, S. & K. Juselius (1990).*Maximum Likelihood Estimation and Inference on Cointegration with Applications to Demand for Money" Oxford Bulletin of Economics and Statistics 52, 169-210*

Janathan E Ogbuabor N. Emmanuel I E (2017) impact of climate change on the Nigerian economy. International journal of energy economics and policy 7 (2); 217- 223

Jula , D., C Dumitrescu, L. Lie(2015)*Environmental Kuznets Curve. Evidence from Romania, Theoretical and Applied Economics, AsociatiaGenerala a Economistilor din Romania - AGER,85-96.*

Kamande, W. (2007). Environmental Conservation as an Engine for Economic Growth: Testing the Validity of Environmental Kuznets Curve on Carbon Emissions for Kenya. Unpublished MA Thesis, University of Dares Salaam

Kuznets, S. (1955). Economic Growth and Income Inequality. *American Economic Review 45(1), 1–28.*

Lapinskiene, G., Tvaronaviciene, M., and Vaitkus., P. (2013). Analysis of the validity of environmental Kuznets curve for the Baltic State. *Environmental and Climate Technologies, 4(1), 1-17.*

Maddala, G. S. (2007*). Introduction to Econometrics. New Delhi, John Willey.*

Omotor , D.G.(2016) Economic Growth and Emissions: Testing The Environmental Kuznets Curve Hypothesis For ECOWAS Countries. CEEPA Discussion Paper No.63, September 2016

Perasan H M Shin Y & Smith R (2001) Bound testing approach to the analysis of level relationship *journal of applied econometrics 16 289- 326*

Pesaran, M. H , Richard J. Smith, and Yongcheol Shin(2001) "Bounds Testing Approaches to the Analysis of Level Relationships", *Journal of Applied Econometrics, 16(3),289-326*

Selden, T. M., & Song, D. S. (1994). Environmental quality and development: Is there a Kuznets curve for air pollution emission? *Journal of Environmental Economics and Management, 27,* 147-162. https://doi.org/10.1006/jeem. 1994.1031

Seldon, T. M., & Daqing Song.(1994) Environmental Quality and Development: Is There a Kuznets Curve for Air Pollution Emissions? *Journal of Environmental Economics and Management 27, 147–62..*

Stern, D. (2004). The rise and fall of the environmental Kuznets curve. *World Development, 32 (8),1419-1439*. https://doi.org/10.1016/j.worlddev.2004.03.004

Shabaz, M., Dube, S., Ozturk, I. & Jali, A. (2015). Testing the Environmental Kuznets curve in Portigal. *International Journal of Energy Economics and policy, 5(2), 475-481.*

World Bank (1992).*World Development Report.New York: Oxford University Press.*