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# Income Inequality, Environmental Degradation and Economic Development Nexus in Nigeria: Reassessing the Kuznets Hypothesis

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**ABSTRACT:** This study investigated the relationship between income inequality, environmental degradation and economic development in Nigeria within the ambit of the Kuznets hypothesis and employed the Autoregressive Distributed Lag (ARDL) technique. The findings indicate the non-existence of the Kuznets hypothesis in Nigeria; rather a scenario of a monotonically increasing relationship is observed between carbon dioxide emissions and economic development in Nigeria, especially in the short run. The results further showed that environmental degradation has a negative impact on economic development, but for Nigeria it is insignificant as in most developing countries; while income inequality however rises with economic development. Given that there is a trade-off between reducing carbon dioxide emissions and income inequality in Nigeria to boost growth and development, a clearly thought-out policy directed towards ensuring that increases in the income of the poor majority are not spent on carbon emitting activities is recommended.

**KEYWORDS:** Income inequality, Kuznets hypothesis, Environmental Degradation, Economic Development, ARDL technique.

## 1 INTRODUCTION

The untoward effect of global warming typified by the melting of the ozone layer, loss of biodiversity, erratic changes in atmospheric conditions, increasing levels of temperature, rising sea levels, gully erosion and floods has generated renewed interests in understanding the relationship between economic development and environmental deterioration and by implication, how economic development and environmental degradation interact to create income disparities around the world. In their study, [1] observed that there exists a relationship between income inequality and per capita carbon emissions, that for low and middle-income countries, higher income disparities are associated with lower carbon emissions while in upper middle-income and high-income countries, higher income inequality increases per capita carbon emissions. Over the years, there have been tremendous efforts directed towards the drastic reduction of carbon dioxide emissions, environmental progressiveness, more effective and efficient economic transport systems regulation, sustained levels of emit fuel use by industries as well as ameliorating widening income disparities.

In 1955, Kuznets started the analysis of the relationship between income inequality and environmental pollution accompanying the pursuit of economic development; he observes that though income inequality rises with economic development, when a maximum point is reached, it declines steadily as per capita income rises. [2] alluded that economic development is increasingly resulting in carbon dioxide (CO2) emissions, with the level rising to about 30 percent in the late $20^{th}$ century while [3] believe that such high level of pollutants emission could result in the disruption of the environment and create environmental challenges capable of devastating sources of livelihood.

Besides internally generated pollutants, many African countries including Nigeria are haven for the dumping of waste products capable of compounding existing environmental problems. [4] argues that developing countries provide vacant places which serve as pollution haven where industrial wastes are dumped by developed nations. According to a study by the High Emission Scenario (HES) as found in [5], by 2025 Nigeria, Ghana, and Sierra Leone could generate about 5.4, 4.4 and 1.2 million tons of carbon dioxide (CO2), respectively. These emissions account for about six, seven and four folds increase over the current level of emissions. However, the emissions can be reduced by 25 percent, 26 percent and 13 percent respectively if proactive

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measures to abate carbon emissions are introduced as enshrined in the Low Emission Scenario (LES). But considering the fact that developing countries focus fundamentally on faster economic growth and development, they become prone to overuse of their natural resources (owing to the short-run marginal utility of economic development which they assume outweighs the marginal cost of environmental degradation), it would be a herculean task for such to checkmate such emissions. Interestingly, in the short run, developing countries express little willingness to abandon their quests for higher economic growth and development, since they hold the mandate of the citizens to improve their standards of living and to narrow widening income disparities.

Added to the goal of promoting growth and development, there is an increasing global mandate to safeguard the natural environment and prevent further loss of biodiversity [6]. Nigeria is not spared of the destruction of the environment in her quest for economic growth and development. The Niger Delta Region of Nigeria is laden with massive destruction of biodiversity and oil spillage is a case in point, and this does not preclude gully erosion in the South-East and South-South, surging sea levels in the South-West, and desert encroachment in the North. These environmental challenges have tended to widen the income gap in spite of the numerous measures adopted by the government to stem the scourge such as the formation of the National Emergency Management Agency (NEMA) in 1999, Niger Delta Development Commission (NDDC) in 2000, National Oil Spill Detection and Response Agency in 2006, and others.

Empirical studies in Nigeria such as [7-10], have tended to focus on the income-environment relationship with none of these studies examining how economic development interacts with the environment to create income inequality. This study therefore investigates the relationship between income inequality, environmental degradation and economic development in Nigeria from 1980 to 2016 exploring the Environmental Kuznets Hypothesis. Specifically, the study sets out to:

- examine the short run and long run relationship between carbon emission, economic development and income inequality in Nigeria; and thus, determine the existence or otherwise of the Environmental Kuznets curve (EKC) hypothesis in Nigeria
- investigate the impact of environmental degradation on economic development in Nigeria.
- determine the impact of economic development and environmental degradation on income inequality.

The rest of the study is structured in the following outline: the remaining part of the introduction examines trend analysis and review of empirical and theoretical literature, section two is the methodology and data analysis while section four focuses on discussion of findings and section five gives the summary, conclusion and policy implications**.**

### 1.1 TREND ANALYSIS, EMPIRICAL AND CONCEPTUAL ISSUES

In Nigeria, statistics has showed that as at 1970, carbon dioxide emissions in Nigeria stood at 0.355 metric tons per capita; this however surged to about 0.928 metric tons per capita in 1980, and declined steadily from 1987 (0.674 metric tons per capita) to 0.338 metric tons per capita in 1999; thereafter, Nigeria witnessed a significant rise in the emissions of carbon dioxide to about 0.770 metric tons per capita in 2004. The emissions declined marginally to about 0.571 metric tons per capita as at 2016 [11]. The trend is graphically demonstrated in figure one.

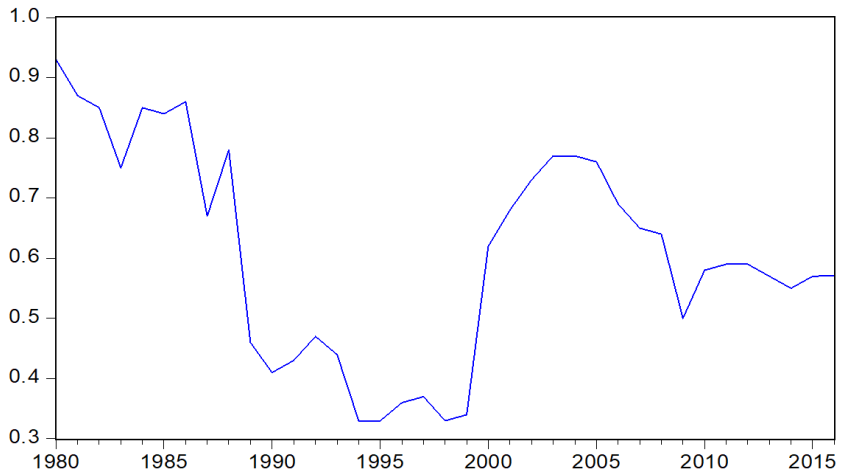


***Fig. 1. TRENDS IN CO2 EMISSIONS (PER CAPITA METRIC TONS)***

Source: Authors computation, 2018

Incorporating economic development (proxy by per capita GDP) and income inequality (proxy by per capita military spending) into the analysis, available data from the World Bank Development Indicators (WDI) from 1980 to 2016 indicate that per capita income in Nigeria estimated to be 873.96 US dollars in 1980 plummeted immensely to about 153.65 US dollars in 1993, it however increased significantly to an all-time high of about 3,221.68 US dollars in 2014, but from 2015 per capita income started declining marginally to 2,177.99 US dollars in 2016. This notwithstanding, per capita military spending (that is, total military spending to population ratio) which was estimated to be 24.20 naira per person in 1980 has been on the increase, rising to about 2,387.75 naira per person as at 2016. This exemplifies the widening income inequality in Nigeria as shown in figure two.

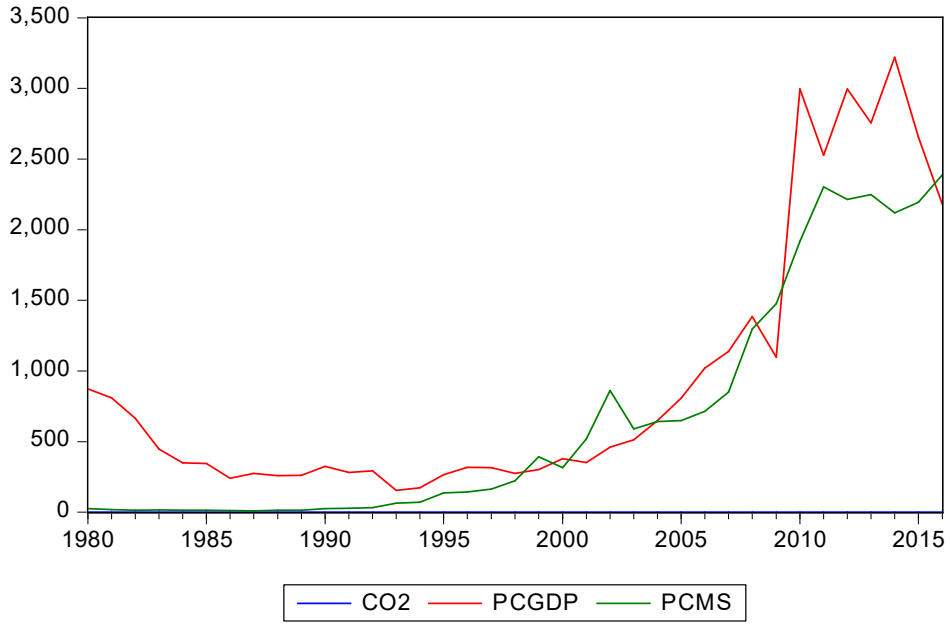


***Fig. 2. TRENDS IN CO2, PCDGP, AND PCMS***

**Source**: Authors computation, 2018

The conceptualization of the environmental Kuznets hypothesis started in 1955 by a study carried out by Simon Kuznets. He opined that, as per capita income increases, the level of income disparity rises at the initial stage and then, after approaching a maximum or turning point, it diminishes. Thus, the Kuznets curve is postulated to have an inverted U-shaped relationship between per capita income and income inequality. In other words, at an initial stage of income growth, an economy exhibits more unequal distribution of income than at any other stage of the growth process, given that as an economy develops, its growth is further consolidated. In terms of the relationship between environmental degradation and economic development (proxy by real per capita income), the Environmental Kuznets Curve (EKC) hypothesis argues that environmental degradation and income growth portray a U-shaped relationship as in the case of income disparity and economic growth, especially in the developing economies. Juxtaposing the two perspectives (the income inequality and per capita income perspective, and the environmental degradation and per capita income perspective), the Environmental Kuznets Curve (EKC) hypothesis is employed to ascertain the relationship between economic development and the environment deterioration. Available literature on this body of knowledge indicates that only a few studies have examined the two aspects of the Kuznets hypothesis, [1, 12-16], with none in Nigeria that investigates the two perspectives.

In an attempt to establish an empirical evidence of the existence or otherwise of the Environmental Kuznets Curve (EKC) hypothesis employing different measures of environmental degradation, econometric approaches and datasets, several studies have been carried out at both cross-country and country-specific levels. The existing body of knowledge reveals a general lack of consensus as regards the relationship between environmental deterioration and economic development. To facilitate the actualization of the specific objectives of this study, the following cross-country and country-specific studies were reviewed under two strands of thought: the studies that examined the role of income inequality in the relationship between

per capita income and environmental degradation, and the other which dealt with a direct relationship between per capita income and environmental degradation.

### 1.2 PER CAPITA INCOME, INCOME INEQUALITY, AND ENVIRONMENTAL DEGRADATION

[12] using 1000 locations worldwide examined "income, inequality, and pollution: a reassessment of the environmental Kuznets curve" from 1977 to 1991. The findings from the panel data estimation indicate that for sulphur dioxide (SO2) and carbon emissions, the case of U-shape is established. The results show that pollution initially rises with per capita income and then declines. Thus, the statistical significance of income effects generally diminishes when the inequality variables are included as regressors. That greater income inequality is associated with more pollution in low-income countries, but not in high-income countries.

[16] studied economic growth, income inequality and environment: assessing the applicability of the Kuznets hypothesis to twenty Asian countries. Using descriptive statistics, the results show that the Kuznets inverted U-curve hypothesis is valid with some limitations. It was observed that trends in both income inequality and environmental deterioration appear to follow the Kuznets' hypothesized curve up to the lower level of high income as income rises; whereas a divergent trend was observed among high-income countries. Thus, growth impacts on income inequality and environmental degradation differ substantially among high-income countries; whereas among countries with lower income, growth impacts on income inequality are generally small, the impact on environment is quite significant. [15] analyzing the possible impact of income inequality on environmental quality for 23 provinces in China from 1995 to 2012 with the generalized method of moments (GMM) observed that CO2 emissions per capita increases as the income gap expands for nationwide, and in the eastern and non-eastern regions of China.

Also, [1] investigated the trade-off between income inequality and carbon emissions in 153 countries from 1980 to 2008. Using a panel data estimation technique, the results show that there exists a relationship between income inequality and per capita carbon emissions, and it depends on the level of income. The results further indicate that for low and middle-income economies, higher income inequality is associated with lower carbon emissions while in upper middle-income and high-income economies, higher-income inequality increases per capita carbon emissions.

[13] examined the impact of economic inequality on environmental degradation from 2007 to 2011 using theoretical and empirical reviews. The review identified two channels through which environmental deterioration interacts with economic growth to create income inequality. The channels are economic and political channels, each having its internal diversity. While the first channel relates aggregate environmental deterioration to economic behaviour of individuals, the second channel focuses on the implementation of public policy aimed at protecting the environment. Thus a recursive approach for investigating the relationship between income inequality and environmental deterioration is advanced.

### 1.3 PER CAPITA INCOME AND ENVIRONMENTAL DETERIORATION

[17] carried out a study on the modeling of carbon dioxide emissions and economic growth in Croatia from 1992Q1 to 2011Q1. Employing Autoregressive Distributed Lag (ARDL) model and Vector Error Correction Model (VECM), they observe that for Croatia, there exists an inverted U-shaped relationship between CO2 emissions and economic growth in the long run, thus validating the EKC hypothesis. The Granger-causality based on the VECM approach shows a bi-directional causality between CO2 emissions and economic growth in the short run, and in the long run, a uni-directional causality running from economic growth to CO2 emissions.

[6] investigated the importance of population control and macroeconomic stability to reducing environmental degradation in developing countries from 1972 to 2011 using a panel data estimation technique; the results indicate that the EKC hypothesis is valid for developing countries, and that the actualization of greater economic growth in developing countries has had a severe impact on the quality of the environment. Other studies that have established the validity of the environmental Kuznets (EKC) hypothesis include: [4, 12, 15, 18-20] On the other hand, [21] investigated economic growth and environmental pollution in West Africa: testing the environmental Kuznets curve (EKC) hypothesis from 1970 to 2013 by employing panel data estimation technique. It is observed that economic growth in the short run significantly increases CO2 emissions, and in the long run it does not reduce carbon emissions. The insignificant relationship between economic growth and environmental deterioration connotes the non-existence of the EKC hypothesis in West Africa. The results therefore indicate that the Kuznets hypothesis cannot be used to explain economic growth and environmental deterioration nexus in West Africa. [22] conducted a study on economic growth and environmental impacts: an analysis based on a composite index of environmental damage. Exploring panel data for 152 countries for a period of six (6) years facilitated by panel data estimation approach, they observe that the environmental Kuznets curve (EKC) hypothesis does not exist for the countries under investigation. [23] in their

empirical analysis of the relationship between CO2 emissions and economic growth in West Africa from 1970 to 2011 using panel data method, argue that in the long run, there is a co-integrating relationship between carbon emissions, GDP and other covariates. The results also indicate that in the long run, there is an N-shaped relationship between income and carbon emissions; again, invalidating the existence of the EKC hypothesis in West Africa. It is further shown however that in the short run, economic growth, population growth rate, domestic credit to the private sector and trade openness granger-cause the emissions of carbon dioxide. [10] studied the relationship between environmental quality and economic growth in Nigeria: a fractional cointegration analysis from 1970 to 2011. The results indicate that at the initial level of development in Nigeria, environmental degradation increases. It is further reported that weak institution and unrestricted trade openness increase the degree of environmental pollution owing to environmental dumping. The study could not also establish a reasonable maximum or turning point; and thus, it reinforces the non-existence of the EKC hypothesis in Nigeria. Related studies that have arrived at similar conclusions include: [7-9, 14, 24-26] Interestingly, in analyzing the environmental Kuznets (EKC) hypothesis, several studies have also found mixed results arguing that the validity of the EKC hypothesis depends on the datasets employed; such studies include [10, 27-31]

## 2 METHODOLOGY AND ANALYSIS

### 2.1 DATA ISSUES

Secondary data is employed for this study spanning the period 1980 to 2016. The variables used in the study are real per capita GDP (2005 US dollars), per capita carbon dioxide emissions, per capita military spending as proxy for inequality (the traditional Gini coefficient as a measure of income inequality was not available for Nigeria on a consistent basis; and studies have shown that higher per capita military spending signals higher income inequality vis-à-vis other countries), and trade openness. The real per capita GDP was sourced from the World Bank Development Indicators for the period 2016 and 2017, per capita carbon dioxide emissions in metric tons is found in Carbon dioxide Information Analysis Centre Database, USA, trade openness is from the National Bureau of Statistics (NBS) and the World Bank data for 2016 and 2017, respectively; and the military spending is sourced from Stockhom International Peace Research Institute (SIPRI) yearbook on Armaments, Disarmament and International Security. The analytical technique used in the study is autoregressive distributed lag (ARDL) model following [32-33]

### 2.2 MODEL SPECIFICATION

The models for this study are specified adopting the analytical framework of Kuznets (1955), while following [34] and [6] with some modifications.

Model 1: This model is framed to achieve objective one which is to examine the short and long run relationship between economic development, income inequality and environmental degradation as well as the existence or other wise of EKC hypothesis. The model is:

PCCO2 = f (RPCGDP, SRPCGDP, CRPCGDP, INEQ, TOPNS) (1)

$$PCCO_{2t} = a_0 + a_1(RPCGDP)_t + a_2(SRPCGDP)^2{}_t + a_3(CRPCGDP)^3{}_t + a_4(INEQ)_t + a_5(TOPNS)_t + \varepsilon_t \quad (2)$$

Model 2: In order to achieve objective two which is to investigate the impact of environmental degradation on economic development, model two was specified thus:

RPCGDP = f (PCCO2, INEQ, TOPNS) (3)

$$RPCGDP_t = b_0 + b_1(PCCO2)_t + b_2(INEQ)_t + b_3(TOPNS)_t + \mu_t \quad (4)$$

Model 3

To achieve the third objective of the study which attempts to ascertain the impact of economic development and environmental degradation on income inequality, this model was specified thus:

INEQ = f (RPCGDP, PCCO2, TOPNS) (5)

$$INEQ_t = \phi_0 + \phi_1(RPCGDP)_t + \phi_2(PCCO_2)_t + \phi_3(TOPNS)_t + \nu_t \quad (6)$$

A priori:

$a_1 > 0,\ a_2 < 0,\ a_3 > 0$ this implies an N-shaped relationship; $a_4 > 0,\ a_5 < 0$ and $a_1 < 0,\ a_2 > 0,\ a_3 < 0$ this connotes an inverted N-shaped relationship; $a_1 < 0,\ a_2 > 0,\ a_3 = 0$ this shows a U-shaped relationship; $a_1 > 0,\ a_2 < 0,\ a_3 = 0$ this gives or validate the EKC hypothesis (an inverted U-shaped). Also, $b_1 < 0,\ b_2 < 0,\ b_3 > 0$; $\phi_1 < 0,\ \phi_2 > 0,\ \phi_3 < 0$, and $a_1 > 0,\ a_2 = a_3 = 0$, this indicates that the relationship is monotonically increasing.

### 2.3 DESCRIPTION OF VARIABLES

PCCO2 = per capita carbon dioxide emissions (in metric tons), RPCGDP = real per capita GDP (2005, US dollar), SRPCGDP = squared real per capita GDP, CRPCGDP = cube real per capita GDP, IENQ = income inequality (which has been proxy by per capita military spending; this is obtained by dividing the total military spending by the total population), and TOPNS = trade openness (it is obtained by dividing the sum of import and export by the gross domestic product).

### 2.4 DATA ANALYSIS

The empirical analytical technique employed for this study included pre-estimation tests, estimation and post-estimation tests.

## 3 RESULT

### 3.1 UNIT ROOT AND BOUND TESTS RESULT

The result indicated that cubed real per capita gross domestic product (CRPCGDP) was stationary at level while real per capita GDP (RPCGDP), squared real per capita GDP (SRPCGDP), per capita carbon emission in metric tons (PCCO2), Per capita military spending (PCMS) and trade openness (TOPNS) were found to be stationary after first differencing. The variables are not spuriously related; therefore, they are appropriate for this study.

***Table 1. Summary of the ADF unit root test***

| Variables | Levels | First Difference | I(d) |
|---|---|---|---|
| PCCO2 | | -6.472206***b | I(1) |
| RPCGDP | | -8.514392***a | I(1) |
| SRPCGDP | | -8.952746***b | I(1) |
| CRPCGDP | 4.593035***a | | I(0) |
| PCMS | | -4.593035***a | I(1) |
| TOPNS | | -8.266142***b | I(1) |

****, **, *; represent 1%, 5%, and 10% levels of significance respectively and (a), (b) respectively indicate constant and trend, and none (that is no trend and no intercept).*
*Source: Authors computation, 2018*

***Table 2. Automatic Maximum Lag Selected Model***

| Model Selected | Number of Models Evaluated | Model Selected Criterion | $R^2$ | D-w | F-Statistic |
|---|---|---|---|---|---|
| **ARDL (1,2,2,1,0,0)** | 12500 | (AIC) 10.43587 | 0.999663 | 2.27093 | 318.195 0.00025 |

*Source: Authors computation, 2018*

The results in Table 2 show that ARDL (1, 2, 2, 1, 0, 0) is the Parsimonous outcome automatically selected by e-views after evaluating 12500 models. The model thus selected has the lowest AIC of 10.43587 with high $R^2$ of 0.99966 and D-W value of 2.270928 indicating the non-existence of autocorrelation or first order serial correlation in the estimated model. The F-statistic value of 318.1951 shows the model is statistically significant at 1 percent and 5 percent levels of significance; and it can be used to examine the relationship between environmental degradation, economic growth and income inequality.

***Table 3. Summary of the Bounds test***

| **Test Statistic** | **Value** | **Variables** |
|---|---|---|
| **F-statistic** | 5.142377*** | 5 |
| | Critical Value Bounds: | |
| **Significance** | **I0** | **I1** |
| **10%** | 2.26 | 3.35 |
| **5%** | 2.62 | 3.79 |
| **2.50%** | 2.96 | 4.18 |
| **1%** | **3.41** | **4.68** |

*Source: Authors computation, 2018*

Table 3 summarizes the results of the Bounds co-integration test. The results show that there exists a long-run convergence between environmental degradation (proxy by per capita carbon emission in metric tons), economic growth (as proxy by real per capita Gross Domestic Product) and income inequality (as proxy by per capita military spending) and other control variables namely, squared real per capita GDP, cube real per capita GDP, and trade openness in Nigeria. The outcome of the Bounds co-integration test indicates that at 1 percent level of significance, the F-statistic value of 5.14238 is higher than the upper bound critical value of 4.68. Having established a long run relationship among the variables of interest, the estimation of an error correction model is also necessary and this is achieved by estimating the short run and long forms of the ARDL model.

***Table 4. Short Run Coefficient Analysis***

| Variables | Coefficient | Standard error | t-statistic | p-value |
|---|---|---|---|---|
| D(RPCGDP(-1) | 0.000683 | 0.000283 | 2.417606 | 0.0244 |
| D(SRPCGDP(-1) | 0 | 0 | -2.342593 | 0.0286 |
| D(CRPCGDP) | 0 | 0 | -0.120690 | 0.9050 |
| D(PCMS) | 0.000022 | 0.000178 | 0.123671 | 0.9027 |
| D(TOPNS) | -0.002413 | 0.001714 | -1.408034 | 0.1731 |
| ECT | -0.948276 | 0.199183 | -4.760827 | 0.0001 |

*The values in parenthesis represent the probability values.*
*Source: Authors computation, 2018*

***Table 5. Long Run Coefficient Analysis***

| Variables | Coefficient | Standard error | t-statistic | p-value |
|---|---|---|---|---|
| RPCGDP | 0.000494 | 0.000562 | 0.879072 | 0.3889 |
| SRPCGDP | 0 | 0 | -0.970502 | 0.3423 |
| CRPCGDP | 0 | 0 | 0.999365 | 0.3285 |
| PCMS | 0.000023 | 0.000187 | 0.124047 | 0.9024 |
| TOPNS | -0.002545 | 0.002028 | -1.255132 | 0.2226 |
| C | -0.016341 | 0.020911 | -0.78145 | 0.4429 |

*Source: Authors computation, 2018*

## 4 DISCUSSION

The results from the estimation of equation 1 as presented in table 4, show that error correction term is negative (-0.95) and significant which further confirms the validity of a long-run relationship; and by estimating the error correction model (ECM), the results presented in table 5 are achieved. The results in table 4 indicate that in the short run, there exists positive relationship between carbon dioxide emission, income inequality (0.00022), and economic growth (0.000683), while trade openness and the square of real per capita GDP have an inverse relationship with carbon emissions in Nigeria. The results also show that while real per capita GDP and the square of real per capita GDP are statistically significant, per capita military spending, cube of the real per capita GDP and trade openness are not significant statistically. The coefficients of the real per capita GDP, Squared real per capita GDP and the cube real per capita GDP are in line with the last a priori expectation; it shows that the coefficient of the real per capita GDP is greater that than zero (that is, 0.000683 > 0) while those of squared real per capita GDP and cube real per capita GDP are zeros respectively. The policy implication of these results is that, the environmental Kuznets curve (EKC) hypothesis is not valid for Nigeria; this is in line with the conclusions of [7, 9-10, 21, 23 and 35] as well as [8]. A striking aspect of the results for this study is that the Kuznets curve for Nigeria assumes a monotonically increasing

relationship between environmental degradation and economic development in Nigeria; a result similar to that of [36] Again, the results of the error correction model (ECM) presented in table 5 show that all the variables in the long run are not statistically significant, implying that the hypothesis for Nigeria is a short run phenomenon. The error correction term (ECT) of 0.95 shows that although there is a long run relationship, the speed of adjustment from the long run to back to the short run is almost instantaneous every year.

***Table 6. Summary of results from the estimation of equation (4)***

| Variables | Coefficient | Standard error | t-statistic | P-value |
|---|---|---|---|---|
| PCCO2 | -12.27778 | 552.5383 | -0.022221 | 0.9825 |
| PCMS | 0.655757 | 0.35826 | 1.830398 | 0.0829 |
| PCMS(-2) | 1.247126 | 0.551263 | 2.262308 | 0.0356 |
| TOPNS | 2.612062 | 6.055268 | 0.43137 | 0.6711 |
| R-squared | 0.956 | | | |
| Adjusted R-squared | 0.926 | Durbin watson | 2.263807 | |
| F-statistic | 31.85398 | | | |
| Prob(F-statistic) | 0 | | | |

*Source: Authors computation, 2018*

The results from the estimation of equation (4) which attempts to capture the impact of environmental degradation and income inequality on economic development are shown in table 6. The results indicate that environmental degradation (-12.2778) has a negative impact on economic growth, but it is not statistically significant. For a significant relationship, a 1 metric ton of per capita carbon emissions could inhibit economic growth by 12.2778 US dollars per person; this result is not surprising because [12] had observe that the statistical significance of economic growth and development effects declines when inequality variables are included as explanatory variables. This is because greater inequality is associated with more environmental degradation in low income countries. Per capita military spending which proxy income inequality following [37] has a positive and significant impact on economic growth at 10 percent level of significance; an increase in per capita spending (which implies an increase in income inequality) by 1 naira, will promote economic development by 0.6558 US dollars per person. Similarly, trade openness in Nigeria has positive but insignificant impact on economic growth for the period under study. The adjusted r-squared of 92.6 percent indicates the model has high explanatory power as regards the impact of carbon emissions and trade openness on economic development; it implies that about 92.6 percent of the change in real per capita GDP has been explained or captured by the variations in per capita carbon emissions, per capita military spending and trade openness. The value of the F-stats (31.85398) shows that the overall model is statistically significant, thus could be used to make forecast. The value of the D-W and LM tests for serial correlation shows that the variables are not serially correlated. Results from the estimation of the third model indicate that only real per capita GDP has positive and significant impact on per capita military spending in Nigeria for the period under study; a 1 US dollar increase in real per capita income causes per capita military spending to rise by 0.1278 naira per person. This result is valid since at agrees with the conclusion of [21] in their study on economic growth and environmental pollution in West Africa: testing the environmental Kuznets hypothesis, they argue that economic growth in the short run significantly raises carbon dioxide emissions and does not significantly reduce CO2 emissions in the long run.

## 5 SUMMARY, CONCLUSION AND POLICY IMPLICATIONS

This study focused on income inequality, environmental degradation and economic development in Nigeria: a reassessment of the Kuznets hypothesis using time series data from 1980 to 2016. The autoregressive distributed lag (ARDL) estimation technique was explored with the Bounds test for co-integration. The error correction term (ECT) validated the existence of a long run relationship between environmental degradation, economic development and income inequality. The results further showed that in the short run, there exists positive relationship between carbon dioxide emission and income inequality as well as with economic development, while trade openness and the square of real per capita GDP have an inverse relationship with carbon dioxide emission. The coefficients of the real per capita GDP, squared real per capita GDP and the cube real per capita GDP were in line with their a priori expectation. It showed that the coefficient of the real per capita GDP is greater that than zero (that is, 0.000683 > 0); while those of squared real per capita GDP and cube real per capita GDP are zeros, respectively indicating a monotonically increasing relationship. Thus, the EKC hypothesis is not validated for Nigeria. The value of the ECT (95 percent) indicates that although a long run relationship was established the speed of adjustment from the short run to the long run is almost instantaneous, again invalidating the inverted U-shaped relationship.

On how environmental degradation and income inequality influence economic development, the results indicate that environmental degradation has a negative impact on economic growth, but it is not statistically significant. This result is not surprising because [12] had observed that the statistical significance of economic growth effects declines when inequality variables are included as explanatory variables. This is because greater inequality is associated with more environmental degradation in low income countries. Also, by assessing how economic growth and environmental degradation interact to create income inequality, the study found that income inequality rises with increased economic growth and development in Nigeria, especially in the short run.

The study thus concludes that the environmental Kuznets curve (EKC) hypothesis does not hold for Nigeria. The policy implication of the findings lies in the monotonically increasing relationship among the variables of interest. It implies that even if the hypothesis is applied in Nigeria, a high proportion of the total population will still be around the initial stage of the environmental Kuznets curve; thus, economic development policy anchored on this relationship would further aggravate environmental degradation in the country. The study therefore recommends that the relevant authorities should design environmental policies that would trigger higher income earnings for the poor which ensures that higher carbon dioxide emission is not generated in Nigeria. A very potent way is to diversify the country's energy mix by promoting the exploration of the vast renewable resources in the country. Also, a continuous sensitization programme on the relevance of using cleaner energy sources, effective storage system as well as CO2 trading schemes is advanced. This is pivotal because in poorer countries (Nigeria inclusive) there is a clear trade-off between reducing carbon emissions and income inequality vis-à-vis economic growth and development.

## REFERENCES


[1] Grunewald, N., Klasen, S., Zarzoso, I. M., & Muris, C. (2017). The Trade-off Between Income Inequality and Carbon Dioxide Emissions. *The Journal of Ecological Economics, No. 412, Pp. 249-256.*

[2] Heil, T. M., & Selden, T. (2001). Carbon Emissions and Economic Development: Future trajectories based on Historical Experience. *Journal of Environment and Development Economics, vol.6, issue 01, Pp. 63-83*

[3] Shi, H., Moriguichi, Y., & Yang, J. (2008). Industrial Ecology in China: Part II Education. *Journal of Industrial Ecology vol. 7, issue 1*

[4] Zaman, K. & Moemen, M. A. (2017). Energy consumption, Carbon dioxide emissions and Economic Development: Evaluating Alternative and plausible Environmental Hypothesis for Sustainable growth. *Journal of Renewable and Sustainable Energy Reviews, No. 74, Pp. 1119-1130*

[5] Omojolaibi, J. A. (2010). Environmental quality and Economic growth in some selected West African countries. *Journal of Sustainable Development, vol. 12, No. 8, Pp. 35-48*

[6] Hanif, I. & Gago-de-Santos, P. (2017). The Importance of Population control and Macroeconomic Stability to reducing environmental degradation: An empirical test of the environmental Kuznets Curve for developing countries. *Journal of Environmental Development (in Press).*

[7] Omasakin, O. A. (2009). Economic growth and Environmental quality in Nigeria: Does Environmental Kuznets Curve Hypothesis hold? *Environmental Research Journal, 3(1), 14-18*

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

[9] Akpan, U. F., & Chuku, A. C. (2011). Economic Growth and Environmental Degradation in Nigeria: beyond the Environmental Kuznets Curve. A Revised Paper Presented at the Annual NAEE/ IAEE International Conference

[10] Alege, P. O., & Ogundipe, A. A. (2013). Environmental Quality and Economic growth in Nigeria: A fractional Co-integration Analysis. *International Journal of Development and Sustainability, Vol. 2, No. 2*

[11] Carbon dioxide Information Analysis Centre Data Archives, 2017.

[12] Torras, M. & Boyce, J. K. (1998). Income, Inequality, and Pollution: A Reassessment of the Environmental Kuznets Curve. *Journal of Ecological Economics, No. 25, Pp. 147-160*

[13] Berthe, A., & Elie, L. (2015). Mechanisms Explaining the Impact of Economic Inequality on Environmental Deterioration. *The Journal of Ecological Economics, No.116, Pp.191-200.*

[14] Robalino-Lopez, A., Mena-Nieto, A., Garcia-Ramos, J. E., & Golpe, A. A. (2015). Studying the Relationship Between Economic Growth, CO2 emissions, and the environmental Kuznets curve in Venezuela (1990-2025). *Journal of Renewable and Sustainable Energy Reviews, No. 41, Pp. 602-614*

[15] Hao, Y., Chen, H., & Zhang, Q. (2016). Will Income Inequality Affect Quality? Analysis based on China's Provincial Panel data. *Journal of Ecological indicators, No. 67, Pp. 533-542*.

[16] Ota, T. (2017). Economic Growth, Income Inequality and Environment: Assessing the Applicability of the Kuznets Hypothesis to Asia. *Palgrave Communications Journal, No. 69*

[17] Ahmad, N., Du, L., Lu, J., Wang, J., Li, H. Z., & Hashmi,M. Z. (2016). Modeling the CO2 emissions and Economic Growth in Croatia: Is there any Environmental Kuznets Curve? *International Journal of Energy*

[18] Hassan, S. A. & Gul, S. (2015). The Relationship Between Growth-Inequality-Poverty Triangle and Environmental Degradation: Unveiling the Reality. *Arab Economics and Business Journal, vol. 10, Pp. 57-71*

[19] Tan, F., Lean, H. H., & Khan, H. (2014). Growth and Environmental Quality in Singapore: Is there any trade-off? *Journal of Ecological Indicators, http://dx.doi.org/10.1016/j.ecolind.2014.04.035*

[20] Saboori, B., Sulaiman, J., & Mohd, S. (2012). Economic Growth and CO2 Emissions in Malaysia: A Co-integration Analysis of the Environmental Kuznets Curve. *Journal of Energy Policy, No. 51, Pp. 184-191*

[21] Adu, D. T. & Denkyirah, E. K. (2017). Economic Growth and Environmental Pollution in West Africa: Testing the Environmental Kuznets Curve Hypothesis. *Kasetsart Journal of Social Sciences, XXX, Pp. 1- 8.*

[22] Almeida, T. A., Cruz, L., Barata, E., & Garcia-Sanchez, I. (2017). Economic Growth and Environmental Impacts: An Analysis based on a Composite Index of Environmental Damage. *The Journal of Ecological Indicators, No. 76, Pp. 119-130.*

[23] Muftau, O., Iyoboyi, M., & Ademola, A. S. (2014). An Empirical Analysis of the Relationship Between CO2 Emissions and Economic Growth in West Africa. *American Journal of Economics, vol.4, No. 1, Pp.1-17.*

[24] Ozokcu, S. & Ozdemir, O. (2017). Economic Growth, Energy and the Environmental Kuznets Curve. *Journal of Renewable and Sustainable Energy Reviews, No.72, Pp. 639-647*

[25] Akbostanci, E., Asik, T. S., & Tunc, G. I. (2009). The Relationship between income and Environmental in Turkey: Is there an Environmental Kuznets Curve? *Journal of Energy Policy, No. 37, Pp. 861- 867.*

[26] Grossman, G. M., & Krueger, A. B. (1995). Economic growth and the Environment. *The Quarterly Journal of Economics, Vol. 110, No.2, Pp. 353-377*

[27] Olale, E., Ochuodho, T. O., Lantz, V., & Armali, J. (2018). The Environmental Kuznets Curve Model for Greenhouse Gas emissions in Canada. *Journal of Cleaner Production, XXX*

[28] Alam, M. M., Murad, M. W., Hanifa, A. N., & Ozturk, I. (2016). Relationships among Carbon Emissions, Economic Growth, Energy Consumption and Population Growth: Testing Environmental Kuznets Curve Hypothesis for Brazil, China, India and Indonesia. *Journal of Ecological Indicators, No. 70, Pp. 466 – 479.*

[29] Azam, M., & Khan, A. Q. (2016). Testing the Environmental Kuznets Curve Hypothesis: A Comparative Empirical Study for low, lower middle, upper middle and high income countries (Tanzania, Guatemala, China and the USA). *Journal of Renewable and Sustainable Energy Reviews, No. 63, Pp. 556-567.*

[30] Fodha, M., & Zaghdoud, O. (2010). Economic Growth and Pollutant Emissions in Tunisia: An Empirical Analysis of the Environmental Kuznets Curve. *The Journal of Energy Policy, No. 38, Pp. 1150-1156.*

[31] Onafowora, O. A. & Owoye, O. (2014). Bounds Testing Approach to Analysis of the Environmental Kuznets Curve Hypothesis. *Journal of Energy Economics, No. 44, Pp.47-62*

[32] Pesaran, M. H., Shin, Y. & Smith, R. J. (2001). Bounds Testing Approaches to the Analysis of Level Relationships. *Journal of Applied Economics, No. 16, Pp. 289-326.*

[33] Narayan, P. K. (2005). The Saving and Investment Nexus for China: Evidence from Cointegration Tests. *Journal of Applied Economics, No. 37, Vol. 17, Pp. 1979-1990.*

[34] Zhang, C. & Zhao, W. (2014). Panel Estimation for Income Inequality and CO2 Emissions: A Regional Analysis in China. *Journal of Applied Energy, No. 136, Pp.382-392*

[35] Lin, B., Omoju, O. E., Nwakeze, N. M., Okonkwo, J. U. & Megbowon, E. T. (2016). Is the Environmental Kuznets Curve Hypothesis a sound basis for Environmental Policy in Africa? *Journal of Cleaner Production*

[36] Ekins, P. (1997). The Kuznets Curve for the Environment and Economic Growth: Examining the Evidence. *Environment and Planning, No. 29, Issue 5, Pp. 805-830.*

[37] Tongur, U., & Elveren, A. Y. (2012). Military Expenditures, Inequality, and Welfare and Political Regimes: A Dynamic Panel Data Analysis. Economic Research Centre (ERC) Working Paper in Economics.