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-RESEARCH ARTICLE-

CONSEQUENCE OF ENVIRONMENTAL POLICY ON THE DYNAMICS OF ECONOMIC GROWTH AND ENVIRONMENTAL DEGRADATION IN NIGERIA

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─Abstract─

Recently, more attention has been given to the growth effects of a deterioration in the quality of the environment due to increased accumulation of emissions. Studies have put forth several hypotheses represented by Environmental Kuznets Curve (EKC) which postulate there is an inverted–U-shaped relationship between per capita income and indicators of environmental degradation. Despite the proliferation of research on the EKC hypothesis, no consensus has been reached in the field regarding the validation of the hypothesis. The purpose of this paper is to contribute to the debate concerning the relationship between per capita GDP and per capita emissions of the greenhouse gas carbon dioxide (CO2) to observe the possible influence of economic growth on environmental degradation in Nigeria. This paper uses an Environmental Kuznets Curve (EKC) analysis approach. During the paper, the consequence of environmental policy on environmental quality in the country was investigated. Time series data spanning the period 2000-2019 is used and the Auto Regressive Distributed Lags (ARDL) approach to co-integration is adopted for the purpose of analysis. Concerning CO2 emission, the anticipated EKCs is not found to exist in this study. The coefficient of log of GDP (Gross Domestic Product) is -41.4 and that of log of GDP^2 is 5.3. This fallows 'U' shape instead of inverted 'U' shape curve for Nigeria. Furthermore, a 1% change in log of EPO (environment policy) in the previous year leads to a decrease in environmental degradation by 2.4% of that unit change in the short run. There is need for a clean revolution in industrial production in Nigeria. In addition, more local and national sustainability efforts are needed on several fronts, especially vis-a-vis water and sanitation, as well as in terms of air quality.

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Keywords: Environmental Kuznets Curve, Environmental Policy, Environmental Degradation, Economic Growth, Auto Regressive Distributed Lag

1. INTRODUCTION

There is a long-standing debate on the relationship between economic development and environmental quality (Galeotti et al., 2006). From a sustainable development viewpoint, there has been a growing concern that the economic expansion of the world economy will cause irreparable damage to our planet. In the last few years, several studies have appeared to be dealing with the relationship between the scale of economic activity and the level of pollution Schmalensee et al. (1998); Taskin et al. (2000); Halkos (2003); Galeotti et al. (2006); Day et al. (2003); Bertinelli et al. (2005); Nguyen Van (2005); Ramcke (2009);Shahbaz et al. (2018); Dizaji et al. (2016); Zambrano-Monserrate (2016); Chng (2019); Chen et al. (2019); Shikwambana et al. (2021). If we concentrate on local pollutants, several empirical studies have identified a bell-shaped curve linking pollution to per capita GDP (in the case of global pollutants like CO_2, the evidence is less clear-cut). This behaviour implies that, starting from low per capita income levels, per capita emissions or concentrations tend to increase but at a slower pace. After a certain level of income (which typically differs across pollutants) – or the "turning point" – pollution starts to decline as income further increases. In analogy with the historic relationship between income distribution and income growth, the inverted-U relationship between per capita income and pollution has been termed "Environmental Kuznets Curve".

The purpose of this paper is to contribute to the debate concerning the relationship between per capita GDP and per capita emissions of the greenhouse gas carbon dioxide (CO_2) to gauge the possible influence of economic growth on environmental degradation in Nigeria. The examination of EKC relationship in this study is essential for Nigeria as her major foreign earning economic activities is pollution intensive. Statistics show that between 1973 and 2008, the share of crude oil and gas production in total GDP ranged between 21.1 per cent and 37.5 per cent; whereas, output from the service sector (with less pollutants) has been between 6.7 per cent and 16.3 per cent for the same period (Alege et al., 2015). The National Bureau of Statistics (NBS) in its GDP Q3 2015 reported that the Crude Petroleum and Natural Gas sub-sector accounted for N1.845 trillion, rising from N1.614 trillion in Q2 2015, and also an improvement when compared to N1.826 trillion recorded in 2014 (Eboh, 2015). The contribution of the Crude Petroleum and Natural Gas sub-sector, according to the NBS, represented 10.27 per cent of the country's total real GDP, and is an improvement on the N1.614 trillion recorded in Q2 2014 (Eboh, 2015). The oil sector slowed the nation's real Gross Domestic Product (GDP) to 1.50 per cent in the second quarter of 2018 from 1.95 per cent recorded in the first quarter of the year (Iloan, 2018). Analysis showed that GDP growth within the period was constrained by oil GDP with crude oil and gas production

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contracting by -3.95 per cent compared to 14.77 per cent in the first quarter of 2018 and 3.53 per cent in second quarter of 2017 (Iloan, 2018).

The level of environmental degradation in this paper is quantified as per capita carbon dioxide (CO_2) emissions. It is well known that (CO_2) is one of the worst pollutants contributing to environmental issues (Houghton, 1996). According to Ejuvbekpokpo (2014) in 2016, CO_2 emission intensity for Nigeria was 0.08 kg per 1000-dollar GDP.

Many studies conducted in Nigeria mostly estimate the feasibility of EKC (A.O, 2009)); Bello et al. (2010); Akpan et al. (2011); Ogboru (2015); Akomolafe et al. (2015); Ominyi (2017); Ozigbu (2019); Oriavwote (2019); Olatayo1 (2019); Sani et al. (2022). However, this study not only estimates the feasibility of EKC in Nigeria, but it also attempts to fill in a gap in the literature by investigating the consequences of environmental policy on environmental quality in the country. This is because of the strong rationale for environmental policy. Externalities associated with pollution and the exploitation of natural resources (indeed the most common examples of externalities) call for intervention. It is widely believed that these externalities are large. Without an appropriate environmental policy, the environment is easily overexploited and damaged or exhausted at too fast a rate. The uniqueness of this study is that it provides empirical evidence on the impact of environmental policies on environmental quality in Nigeria and furthers provides evidence upon which existing policies can be amended and new policies formulated. The use of dynamic model (Auto Regressive Distributed Lags (ARDL) in this paper to address the relationship between economic growth and environmental degradation is central to environmental policy because decisions taken now affect not only the current generation but can have a profound impact on the future.

This study is organized in sections. The first section covers the introduction, research problem, significance of the study, objective, and organization of the study. The second section outlines the framework and empirical literature review. The third section describes the materials and methods used in the paper. Section four presents the results and discussions of findings. The fourth section shows the summary and conclusion. The fifth section gives policy recommendations.

2. FRAMEWORK AND LITERATURE REVIEW

The environmental Kuznets curve suggests that economic development initially leads to a deterioration in the environment, but after a certain level of economic growth, a society begins to improve its relationship with the environment and levels of environmental degradation reduce (Pettinger, 2019).

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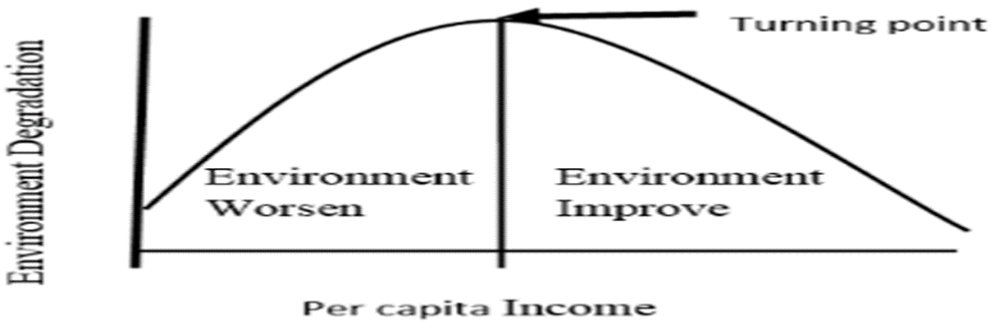

Figure 1: Environmental Kuznets Curve
Source: Khed (2016).

From a very simplistic viewpoint, it is possible to suggest that economic growth is good for the environment. However, critics argue that there is no guarantee that economic growth will lead to an improved environment – in fact, the opposite is often the case (Pettinger, 2019).

Nonetheless, the results of empirical investigation on the EKC hypothesis vary according to environmental degradation indicators and data used (Lawson et al., 2020). Evidence for the existence of the EKC hypothesis is at best mixed in both cross-country and within-country studies conducted in the context of developed and developing economies. For instance, in the cross-country evidence, (Bertinelli et al., 2005) attempt examining the existence of an EKC in a cross-country study using a semi-parametric regression estimator for 122 countries for the period of 1950-1990 and the result was unable to reject the linearity of the relationship between income and pollution. In another similar study, Bertinelli et al. (2005) and Nguyen Van (2005) found evidences in support of EKC for SO2 and CO2.

Ramcke (2009) examined the impact of trade and economic growth on the environment in developed and developing countries. The paper explores the interrelations between economic growth, international trade, and environmental degradation both theoretically and empirically. Panel data from developed and developing countries for the period of 1980 to 2003 was used and previous critiques, especially on the econometric specification, was embedded. The results indicate that there is an Environmental Kuznets Curve (EKC) for most pollutants, but with several reservations. Also, they found that none of the various hypotheses that concern the link between trade and environmental degradation can be entirely confirmed. In addition, the results showed signs that trade liberalization might be beneficial to sustainable development for rich countries, but harmful to poor ones. They concluded that, given that developing countries do not usually have the institutional capacities to set up appropriate environmental policies, it is on developed countries to take the lead in addressing environmental degradation issues and assisting developing countries.

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Dizaji et al. (2016) investigated the relationship between economic growth and environmental quality in D8 member countries. The study examined the relationship between economic growth and environmental quality in Bangladesh, Egypt, Indonesia, Iran, Malaysia, Nigeria, Pakistan, and Turkey using panel data model in the period 1975 –2012. The results showed that economic growth has a positive effect on carbon dioxide emissions. However, the square GDP per capita has a significant negative effect on carbon dioxide emissions. The study concludes that the Environmental Kuznets Curve hypothesis is confirmed from the group of countries understudy. Omotor (2016) examined the relationship between per capita income and environmental degradation in the ECOWAS countries using two indicators of environmental quality of CO2 and SO2 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 CO2 and SO2.

Aye et al. (2017) assessed the effect of economic growth on CO2 emission in developing countries. The panel least squares regression was used to analyze the data for 31 developing countries. The result revealed that economic growth has a negative impact on CO2 emission in periods of low economic growth but positive effects in a period of high economic growth. This finding does not support the EKC hypothesis. Oganesyan (2017) assessed carbon emission, energy consumption and economic growth. The data used were from Brazil, Russia, India, China, and South Korea (BRICs) and covered the period between 1980 and 2015. The panel cointegration result did not support the EKC.

Egbetokun et al. (2020) examined the role of institution in the income –pollution relationship vis-a-vis attaining a turning point in the North and Southern African countries. The study used three measures of air quality, CO2, SO2 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 results indicated that the two regions did not attain the level of income per capita capable of turning the EKC around for CO2 and SO2, but not for SPM. They concluded institutional quality should be strengthened in the two regions. Altıntaş et al. (2020) tested the EKC hypothesis using both CO2 and EF for 14 European countries and finds only EF to be a compatible tool for predicting the EKC. Using EF as an environmental degradation indicator, Ansari et al. (2020) have established the EKC relationship for Central and East Asian countries while using material footprints (MFs) and the relationship is established for all other Asian countries under investigation except central Asia. Danish et al. (2020) have found evidence in favor of the Environmental Kuznets relationship between income and EF for the Next 11 countries and the BRICS countries, respectively.

In a single-country empirical studies, Day et al. (2003) investigated the relationships between growth and environment in Canada using per capita GDP and several environmental indicators. The core study finding is that both environmental and income changes influence the relationship in Canada. Friedl et al. (2003)) explored the relationship between economic development and carbon dioxide in Austria for the period from 1960 to 1999. A cubic relationship between GDP and CO_2 was found to fit the data most appropriately, hence, the EKC hypothesis was not confirmed. Shahbaz et al. (2018) investigated the EKC in Portgual through an ARDL framework using annual data from 1971 to 2008. The findings showed that the EKC exists, thus environmental degradation increases with trade growth, urbanization and energy consumption and then eventually declines. Using the data pertaining to CO_2 emissions, Shahbaz et al. (2018) supported EKC hypothesis for Pakistan while Al-Mulali (2015) did not confirm it for Vietnam. Charfeddine et al. (2017) used the data of Qatar economy and concluded that an inverted U-shaped relationship holds between income per capita and CO_2 emissions and ecological carbon footprint while a U-shaped relationship holds between incomes per capita and total ecological footprint. Mrabet et al. (2017) proved EKC hypothesis using ecological footprint, whereas they could not validate EKC hypothesis using CO_2 emissions. Nonetheless, EKC has been established in the Malaysian economy by Suki et al. (2020) after investigating the impact of globalization. Natural resources have been found to be helpful in supporting the EKC hypothesis, and these resources have a positive effect on the ecological footprint. Sultana et al. (2021) investigated the Environmental Kuznets Curve (EKC) hypothesis and causal links between environmental degradation and selected socioeconomic indicators in Bangladesh for the period 1972–2018. Results from the empirical analysis confirm the existence of the EKC in Bangladesh in both the long and short run.

Empirical studies in Nigeria show A.O (2009) that the relationship between economic growth and environmental quality using Johansen cointegration analysis for the period 1970-2005 with no evidence to support EKC. Bello et al. (2010) used ordinary least square regression analysis to examine whether EKC exists in Nigeria from 1980 to 2008. Findings from the study revealed that there is a U-shaped relationship between CO_2 emission and economic growth in Nigeria. They concluded that CO2 emission in Nigeria is not fueled by economic growth. In 2019, Ozigbu evaluated the validity of Environmental Kuznets Curve Hypothesis in Nigeria. Autoregressive distributed lag (ARDL) model/bounds cointegration test formed the basis for the data analysis. It was observed from the results that the growth-carbon dioxide emissions nexus depicts an invrtted U-shape. It was further found that technological progress is helpful in reducing environmental degradation and by so doing improves environmental quality.

Akpan et al. (2011), in a research work titled "Economic Growth and Environmental Degradation in Nigeria: Beyond the Environmental Kuznets Curve (EKC)" examined the policy relevance of the EKC for Nigeria by applying Autoregressive Distributed Lag (ARDL) framework to annual time series data from 1960 to 2008. The traditional EKC model was extended by including trade openness as well as the shares of manufacturing, agriculture, and service sectors in Nigeria's Gross Domestic Product. Using CO2 emissions per capita to proxy environmental degradation, their findings do not support

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the existence of the EKC hypothesis. Rather it shows that Nigeria's situation when confronted with data is exemplified by an inverse N-shaped relationship with a turning point at $77.27 that lies below the data set used for the study. Based on these findings, the paper posits that the hypothesized EKC serves as a dangerous policy guide to solving environmental problems in Nigeria. The conclusion is that to ensure sustainability, there exists an urgent need to look beyond the EKC by adopting courageous policy measures of environmental preservation in Nigeria irrespective of the country's level of income.

Akomolafe et al. (2015) analyzed the relationship between trade openness, economic growth, and environmental pollution in Nigeria. The study introduced urbanization and ruralization as measures of the growth of urban and rural sectors with a view to analyze their contributions to pollution in the country. Using Vector Error Correction Mechanism (VECM) and co-integration techniques, the result confirms the existence of the Environmental Kuznets Curve in Nigeria. Also, there is a positive relationship between ruralisation and environmental pollution both in the short and long run. However, the result reveals a negative relationship between urbanization and environmental pollution in the long run, but a positive one in the short run. The study concludes with a recommendation that there is a need for policy makers to enact and enforce environmental laws that are aimed at regulating various sources of environmental pollution in the country.

Ominyi (2017) examined the trade-off between economic growth and environmental degradation in Nigeria. The study adopted the Vector Auto Regressive (VAR) approach in addition to the granger causality test to estimate this relationship using time series data from 1986 to 2015. The findings of this study revealed that the Environmental Kuznets Curve (EKC) does not fit the Nigerian data and contradicts the inverted-U hypothesis.

The empirical studies reviewed revealed mixed findings. An inverted-U shaped relationship is reported in many cross-country studies while some of the single-country studies do not provide evidence of an inverted-U shaped relationship. The cross-country analysis assumes that all countries whether underdeveloped, developing or developed, follow the same emissions-income path. This assumption may not be valid and may lead to an incorrect country-specific income-emission relationship. This is due to differences in income levels among countries as well as the differences in their economic and political structures, and the regulations in place concerning the environment (Luk'yanchuk et al., 2010). Some single country studies have decomposed the income - environment relationship and extended their models to capture other variables of interest using different techniques. In Nigeria, a few relevant empirical studies have been undertaken to determine the existence of the EKC hypothesis alongside other factors. The issue of environmental policy has been ignored. Nevertheless, the role of environmental policy is to manage the provision and use of environmental resources in a way that supports improvements in prosperity and wellbeing, for current and future

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generations. To fill the research gap identified, this study examines the existence of EKC hypothesis using current data and examines the effect of environmental policy in improving the quality of the environment in Nigeria. The autoregressive distributed lag (ARDL) approach is deployed in the study. One of the advantages of ARDL is that it is more robust and performs better for small sample size of data which is suitable for this study. Based on empirical analysis, the findings provide a reliable roadmap to policymakers in designing environmental policies that can exploit synergies and minimise trade-offs between environmental effectiveness and economic efficiency. This is a pioneer study in terms of bridging the identified gap in the Nigerian context.

3. MATERIALS AND METHODS

3.1 Model Specification

This study hinges on the theoretical underpinning of the Environmental Kuznets Curve (EKC) which postulates a relation between economic growth and environmental degradation. CO_2 emissions are assumed to be a function of economic growth. In other words, CO_2 is released from economic activities. Therefore, the relationship can be denoted as follows:

$$CO_2 = h(f(Y), \quad (1)$$

Where Y = f(K, L), a production function model (i.e. , traditional production function) with K and L defined as capital and labour, respectively, and *h* denotes the rate of emissions from the production function.

To derive the empirical model for this study, an augmented non-linear relationship between per capita GDP and environmental degradation was specified as follows:

$$CO_2 = f(Y, Y^2, X) \quad (2)$$

Econometrically,

$$LogCO_{2t} = \alpha_0 + \alpha_1 LogY_t + \alpha_2 LogYt^2 + \alpha_3 LogX_t + \mu_t \quad (3)$$

Where X_t is a vector of variables that may often affect environmental quality = [TOP_t, FDI_t, EPO_t]: TOP_t represents trade openness; FDI_t, stands for foreign direct investment; EPO_t is environmental policy (proxy by Environmental Performance Index) ; μ_t is the error term ; and t is the deterministic time trend, used as a crude proxy for technological progress.

The dependent variable CO_{2t} is the CO_2 emissions (in metric tons), and the choice of carbon dioxide as a proxy measure of environmental degradation hinged on the fact that CO_2 emission is the main component of the greenhouse gas (Galeotti et al., 2006).

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The variable Y_t and its quadratic and cubic transformation capture the shape of the EKC function. Y_t shows that early stages of development accelerate the rate of environmental degradation. In this respect, Stern (2004) found an increase in environmental degradation indicators at early developmental stages. The Y_t^2 corroborate to indicate if there is an inverted U-shaped, implying the realization of the EKC. That is, whenever the coefficient of the Y_t^2 is negative; it indicates the existence of the EKC hypothesis. TOP_t, FDI_t, EPO_t represent trade openness, foreign direct investment, and environmental policy respectively. These variables often affect environmental quality. Environmental policy is proxied in this study by Environmental Performance Index (EPI) which is a method of quantifying and numerically marking the environmental performance of a state's policies. It is a controlled variable expected to affect environment positively over time. The key role of environmental policy is to manage the provision and use of environmental resources in a way that supports improvements in prosperity and wellbeing, for current and future generations.

3.2 Data Sources and Measurements

This empirical analysis considers time series data for the following variables over the period of 2000 to 2019. The variables are trade openness, foreign direct investment, population density, and environmental performance index. The choice of this period was to ensure that data for environmental policy proxy by environmental performance index was available.

The sources and measurements of the data employed in the study are presented in Table 1 (see Appendix). All data used in this study have been taken from the secondary source. The data are annual time series in nature. However, time series variables are often non-stationary at levels and an econometrics analysis with these variables results in spurious correlations, that is, a seemingly significant effect though the variables are unrelated in a statistical sense.

3.3 Data analysis and Estimation Techniques

To avoid spurious relations among time series data, the standard current methodology for time series regressions is to check all-time series involved for integration. As such, the stationarity of the data was tested by using Augmented Dickey Fuller (ADF) test which is a conventional time series unit root test. Thereafter, the co-integration test was employed once the stationarity of all data was detected. The three main methods for testing for cointegration are: Engle–Granger two-step method, Johansen test, and Phillips–Ouliaris cointegration test.

The Engle–Granger approach suffers from several weaknesses. Firstly, it is restricted to only a single equation with one variable designated as the dependent variable, explained by another variable that is assumed to be weakly exogeneous for the parameters of interest. It also relies on pretesting the time series to find out whether variables are I(0)

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or I(1). These weaknesses can be addressed using Johansen's procedure. Its advantages include that pretesting is not necessary, there can be numerous cointegrating relationships, all variables are treated as endogenous and tests relating to the long-run parameters are possible. The resulting model is known as a vector error correction model (VECM), as it adds error correction features to a multi-factor model known as vector autoregression (VAR). However, Johansen's test is subject to asymptotic properties, i.e. large samples. If the sample size is too small then the results will not be reliable and one should use Auto Regressive Distributed Lags (ARDL) (Giles, 2017; Pesaran et al., 2001). Based on this, the Auto Regressive Distributed Lags (ARDL) approach to cointegration was adopted in this paper (the ARDL framework is relatively more efficient in the case of small and finite samples).

3.3.1 The basic form of an ARDL regression model is:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \ldots\ldots. + \beta_k\, y_{t-p} + \alpha_0\, xt + \alpha_1 x_{t-1} + \alpha_2\, x_{t-2} + \ldots\ldots\ldots + \alpha_q\, x_{t-q} + \varepsilon t\,, \qquad (1)$$

where ε_t is a random "disturbance" term, which we'll assume is "well-behaved" in the usual sense. It will be serially independent.

The ARDL / Bounds Testing methodology of Pesaran et al. (2001) has a number of features that researchers believe give it some advantages over conventional cointegration testing. For instance, it can be used with a mixture of I(0) and I(1) data, involves just a single-equation set-up (making it simple to implement and interpret), and different variables can be assigned different lag-lengths as they enter the model.

4. RESULT AND DISCUSSIONS

4.1 Unit Root Result

From Table 2, the traditional test of the ADF indicates that all the variables tend to be stationary either at level or in first difference. This is evidenced by the fact that the Absolute Values of the ADF test statistics are all greater than the critical values at either 1% or 5% or 10% levels of significance.

We examined the long run relationship amongst the variables in the model by conducting the ARDL bounds test proposed by Pesaran et al. (2001). The critical values for the bounds test are based on assumptions regarding whether the variables in the model are I(0) or I(1). If the calculated F-statistics exceeds the upper critical value, the null hypothesis is rejected, implying that there is cointegration. However, if it is below the lower critical value, the null hypothesis cannot be rejected, indicating lack of cointegration. If the calculated F-statistics falls between the lower and upper critical values, the result is inconclusive. A maximum lag of 1 was chosen in the ARDL cointegration test. The optimal lag length was chosen in line with Akaike info criterion and the selected ARDL representation for the model was ARDL (1, 1, 1, 1, 0, 0). The results of the ARDL bounds test are presented in Table 3.

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The results indicated no cointegration, as it was insignificant at any of the conventional levels, with the calculated F-statistics falling between the lower and upper critical values. Since there is no cointegration, that means there is no long run and therefore, only the short run ARDL model was estimated.

In Table 4, the short run ARDL results show that LOGGDP(-1), LOGFDI, LOGCO2(-1), LOGEPO, LOGEPO(-1), LOGGDP^2(-1), conform to a priori expectation. This implies that an increase in LOGEPO, LOGEPO(-1), and LOGGDP^2(-1) helps in reducing environmental degradation in Nigeria. Also, as LOGGDP(-1), LOGFDI, andLOGCO2(-1) increase, the likelihood of environmental degradation increases.

Contrarily, LOGGDP, LOGGDP^2, and LOGTOP do no not conform to a priori expectation. The results also reveal that LOGGDP, LOGGDP^2, and LOGEPO(-1) are statistically significant in the short run. However, the coefficients of LOGCO2(-1), LOGGDP(-1), LOGGDP2(-1), LOGEPO, LOGFDI, and LOGTOP are not statistically significant in the short run.

Specifically, the coefficient of LOGGDP suggests that a 1% change in gross domestic product will decrease environmental degradation by -41.4%. This result is contrary to a priori expectation as earlier pointed out but is statistically significant at 10% level. Nigeria has seen remarkable economic growth in recent years and this comes with degradation of the environment because her major foreign earning economic activities (oil) is pollution-intensive (characterized by high levels of CO_2 emission). However, one plausible reason for the negative sign experienced in the regression coefficient of LOGGDP could be as a result of Nigeria adopting a comprehensive strategy policy on climate change with the overarching objective of promoting low-carbon, high-growth economic development and building a climate-resilient society (Schmalensee et al., 1998).

According to Bank (2013), a low-carbon strategy would position Nigeria as a regional and international leader on climate action. Adopting a low-carbon strategy in the power sector, for example, including energy efficiency, solar and wind energy; and combined cycle technology in gas-fired generation, could provide the electricity Nigeria needs to grow, but with cost savings in the order of 7%, and avoiding the emission of close to 2 billion tons of CO_2. In the oil and gas industry, a low-carbon strategy that focuses on reducing natural gas flaring and capturing the gas for commercial use (in the power and other sectors) could generate as much as US$7.5 billion in net additional gains.

Overall, this low-carbon scenario could generate net benefits in the order of two per cent of GDP over 25 years. As such, there is intensive effort at converting flared gas from the Nigerian oil and gas industry to compressed natural gas (CNG), which could be an alternative fuel for bus transit while reducing CO_2 emissions (Otene et al., 2016).

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Table 2: Unit Root Test Result

	Level				First difference			
Variables	Intercept and trend				Intercept and trend			
	Test sta.	1%	5%	10%	Test sta.	1%	5%	10%
CO2	-1.845942	-4.616209	-3.710482	-3.297799	-6.175422	-4.667883	-3.733200	-3.310349
EPO	-3.353488	-4.667883	-3.733200	-3.310349	-4.564112	-4.667883	-3.733200	-3.310349
FDI	-1.118110	-4.616209	-3.710482	-3.297799	-3.406161	-4.728363	-3.759743	-3.324976
GDP	-5.485799	-4.667883	-3.733200	-3.310349	-4.755462	-4.728363	-3.759743	-3.324976
GDP2	-1.589211	-4.728363	-3.759743	-3.324976	-4.677378	-4.800080	-3.791172	-3.342253
TOP	-3.223138	-4.616209	-3.710482	-3.297799	-4.002857	-4.886426	-3.828975	-3.362984

Source: Computed by Author Using eviews software

Table 3: ARDL Bounds Test for Cointegration

Variables	F-statistic	Lags	Critical Values - Restricted Intercept and no trend			Decision
			Significance Level	I (0)	I (1)	
LOGCO2 LOGGDP LOGGDP2 LOGEPO LOGFDI LOGTOP	2.838365	1	10%	2.26	3.35	No Cointegration
			5%	2.62	3.79	
			2.5%	2.96	4.18	
			1%	3.41	4.68	

Source: Computed by Author Using eviews software

4.2 The Short Run ARDL Model Regression Results

Table 4. Short Run ARDL Result

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOGCO2(-1)	0.197252	0.274543	0.718475	0.4957
LOGGDP	-41.39504	20.38478	-2.030684	0.0818
LOGGDP(-1)	34.85661	23.37291	1.491325	0.1795
LOGGDP2	5.286467	2.581044	2.048189	0.0797
LOGGDP2(-1)	-4.611299	2.991011	-1.541719	0.1670
LOGEPO	-0.388726	0.242908	-1.600304	0.1536
LOGEPO(-1)	-2.443415	1.224574	-1.995318	0.0862
LOGFDI	0.137704	0.095186	1.446676	0.1912
LOGTOP	-0.192882	0.129651	-1.487702	0.1804
C	22.74563	19.24056	1.182171	0.2757
R-squared	0.966919	Mean dependent var		-0.618528
Adjusted R-squared	0.924385	S.D. dependent var		0.183729
S.E. of regression	0.050522	Akaike info criterion		-2.843643
Sum squared resid	0.017867	Schwarz criterion		-2.353518
Log likelihood	34.17097	Hannan-Quinn criter.		-2.794924
F-statistic	22.73325	Durbin-Watson stat		1.831040
Prob(F-statistic)	0.000224			
*Note: p-values and any subsequent tests do not account for model selection.				

Source: Computed by author using eviews software

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Other utilization options for flared gas from this industry includes Liquefied Natural Gas (LNG), Liquefied Petroleum Gas (LPG), and power generation.

The coefficient of $LOGGDP^2$ suggests that a 1% increase in $LOGGDP^2$ will spur environmental degradation by 5.3% of that unit change. This result shows statistical significance at 10% level; however, it is not in conformity with the a priori expectation. There is no denying that economic growth brings benefits. However, the ever-increasing scale of production also degrades the environment (CO_2 emission) as shown by the result. That is, environmental degradation increases even after the level of income increases.

Concerning CO_2 emission, the anticipated EKCs is not found to exist in this study (according to the literature on the environmental Kuznets curve, environmental quality does not steadily deteriorate with economic growth). The coefficient of LOGGDP is -41.4 and $LOGGDP^2$ is 5.3. This fallows 'U' shape instead of inverted 'U' shape curve is seen for Nigeria. This result is contrary to Ren et al. (2014); Wang et al. (2016);Lawson et al. (2020); Rafindadi (2016); Shahbaz et al. (2018); Apergis et al. (2017); and Shahbaz et al. (2018) that found inverted U-shape association between CO_2 and GDP and also contrary to Alam et al. (2019) that found an insignificant relationship between CO_2 and GDP in India during the period 1971–2016. However, the result in this study aligns with Bello et al. (2010); Ben Jebli et al. (2015); Alvarado et al. (2018); Destek et al. (2020); Altıntaş et al. (2020) who, in their studies, validated the U-shaped EKC in the relationship between CO_2 emission and economic growth (GDP).

Furthermore, a 1% change in LOGEPO in the previous year will decrease environmental degradation by -2.4% of that unit change in the short run. The coefficient yielded the anticipated sign. This result is in agreement with Panayotou (2000) that investigated the role that policies and institutions play in influencing environmental quality and discovered that better governance and policies make a difference in terms of improving environmental quality. Thus, policies and institutions that focus on development will also affect environmental pollution. The reason for the negative coefficient on LOGEPO in this study could be because of the improvement in Nigeria's environmental policy as indicated by the environmental performance index of recent years. There are many environmental laws and management agencies (institutions) in Nigeria adopted in the effort to protect human health as well as the environment. The country ranked 133 (among 180 countries) and 134 (among 178 countries) in 2016 and 2014 respectively on the EPI (Lawal, 2018). In 2014, the country's framework indicator score was at 8.17% and 72.17% on "Water and Sanitation" and "Air Quality" respectively (Lawal, 2018)**.**

On a general note, while Nigeria's ranking improved in comparison with 2016 and 2014 performance indexes, the 2018 ranking is said to be poor despite having a higher rank in 2018 compared to the previous index years (even though the "total CO_2 emissions intensity" indicator puts Nigeria in the 3rd position which is the country's highest score

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indicator. This means that Nigeria is the third least contributor of CO_2 among the 180 countries considered in 2018 (Lawal, 2018).This is because of the abrupt decrease in both "Water and Sanitation" and "Air Quality" performances from 2016 to 2018 (Lawal, 2018). According to Lawal (2018), the 2018 ranking is unsatisfactorily poor due to the fact that the nation has not done enough to fully explore its sustainability potentials and translate policies into viable actions especially in the areas of water, sanitation and air quality.

The R^2 indicates that the model used in the study has a strong fit, while the F-statistic confirms the adequacy of the model. However, the DW statistics of 1.831040 shows the presence of serial correlation.

5. SUMMARY AND CONCLUSION

The major thrust of this study is to empirically investigate the relationship between economic growth and environmental degradation in Nigeria using the Environmental Kuznets Curve (EKC) approach. Also, among other variables of interest, the effect of environmental policy on environmental degradation in the country was investigated. Time series data spanning the period 2000-2019 were used and the Auto Regressive Distributed Lags (ARDL) approach to cointegration was adopted for the analysis. Specifically, the coefficient of log of GDP (Gross Domestic Product) suggests that a 1% change in gross domestic product will decrease environmental degradation by -41.4%. The coefficient of the log of GDP^2 suggest that a 1% increase in $LOGGDP^2$ will spur environmental degradation by 5.3% of that unit change. Concerning CO_2 emission, the anticipated EKCs is not found to exist in this study. The coefficient of LOGGDP is -41.4 and $LOGGDP^2$ is 5.3. This fallows 'U' shape instead of inverted 'U' shape curve is seen for Nigeria. Furthermore, a 1% change in log of EPO (environment policy) in the previous year leads to a decrease in environmental degradation by -2.4% of that unit change in the short run.

In conclusion, Nigeria has not yet reached the required level of per capita GDP to get an inverted U-shaped EKC. Economic growth without environmental considerations can cause serious environmental damage, consequently impairing the quality of life of present and future generations of Nigeria. As such, targeted policy and attitudes will make sure that economic growth is compatible with an improving environment.

6. POLICY RECOMMENDATIONS

The findings in this paper offer useful policy recommendations for Nigeria's government, the corporate oil sector, environmental agencies, and the citizens:

The nation's oil and gas industry should continue the implementation of activities designed to reduce emission of CO_2 and other greenhouse gases in Nigeria.

There is need for a clean revolution in industrial production in Nigeria. The country needs to transit to a low carbon economy. Many of the technologies needed to achieve this already exist today. However, to capture this value, it is imperative that governments and energy intensive sectors work together to put in place a market framework that will help maintain competitiveness at the same time as delivering a positive change in carbon emissions from industrial output which is both possible and necessary.

To reduce CO_2 emissions and other pollutants while remaining competitive, industry, government and consumers should focus on technologies and interventions that are more cost-effective. There should be more local and national sustainability effort on several fronts, especially in the water and sanitation aspects, as well as in improving the air quality. All hands must be on deck.

Though Nigeria has made substantial progress in developing policies and strategies for water supply and sanitation service delivery, it still faces major challenges translating these into action. These challenges should be dealt with seamlessly. Furthermore, there should be more local sustainability Non-Governmental Organizations devoted to creating awareness and encouraging volunteering in activities relating to water, sanitation, and air quality issues both in urban and rural areas. Initiatives such as roadside waste bins should be incorporated.

7. LIMITATIONS

This paper used per capita carbon dioxide emission as the dependent variable. The carbon dioxide emissions referred to 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 as well as gas flaring. However, the use of only per capita carbon dioxide emissions to proxy environmental degradation may differ from the results that would be obtained using a wide range of other environmental proxies such as air, noise, and water pollutants.

Secondly, due to limited data available on policy variables particularly environmental policies, the environmental performance index was employed. Though EPI Framework has expanded to organize 24 indicators into ten issue categories and two policy objectives namely: (1) environmental health**,** which rises with economic growth and prosperity, and (2) ecosystem vitality, which comes under strain from industrialization and urbanization, however, the number of observations for this variable (EPI) is small for the current analysis which might have affected the study outcomes.

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Appendix

Table 5: Data Sources and Measurements

Variable	Description	Source	Measurement	Expected Outcome
CO_2 emissions	The amount of carbon dioxide (CO_2) emitted, in Carbon dioxide emissions 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.	Knoema	tons per capita	Dependent Variable
GDP/Per capita	GDP per capita is gross domestic product divided by midyear population. GDP is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	Knoema	measured in US dollars	+
GDP/Per capita^2	The variable GDP/capita squared	Knoema	measured in US dollars	-
EPI_t	environmental performance index	Global Metrics for the Environment	index	-
FDI	Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows of investment from the reporting economy to the rest of the world. Data are in current U.S. dollars.	Knoema	measured in US dollars	+
TOP	**7.1 Trade openness: exports plus imports as percent of GDP**	Knoema	measured in %	+

Source: Compiled by author