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The Effect of Sectorial Contributions to GDP on Environmental Degradation: A Verification of the Environmental Kuznets Curve Hypothesis in Nigeria

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Abstract: This paper empirically verifies the validity of the Environmental Kuznets Curve (EKC) hypothesis in Nigeria by focusing on the relationship between key sectors of the Nigerian economy and environmental degradation. The study adopted the Autoregressive Distributed Lag (ARDL) model using time series data for the period 1981-2018. The bounds-testing approach proposed by Pesaran, Shin and Smith, (2001) was adopted to test for cointegration. The results show a long-run relationship between economic growth (disaggregated into key sectors) and environmental degradation measured by carbon dioxide emissions. In the short run, agriculture, industry and services sectors significantly explained the variation in carbon dioxide (CO_2) emissions, while the construction sector does not have any significant effect on Carbon emissions both in the current and the future periods. Specifically, the industrial sector has a positive effect on CO_2 emissions which confirms the short-run EKC hypothesis; while agriculture and services though were significant, have a negative effect on CO_2 emissions, invalidating the short-run EKC hypothesis. In the long run, industry and services sectors were significant in explaining variation in CO_2 emission. However, while the services sector shows a negative relationship with CO_2 emission in line with the long-run EKC Hypothesis, the industrial sector invalidates the hypothesis with a positive effect. These results imply that the key sectors of the economy have varied effects on environmental degradation, hence the hypothesis is inconclusive. Nigeria is therefore advised to pursue economic growth via industrial and services sectors with an emphasis on environmental sustainability, which could be achieved through the use of renewable and cleaner technology in nation-building.

Keywords: *Carbon dioxide Emissions, Environmental Sustainability, Economic Growth.*

1. Introduction

The developmental efforts of a man toward achieving survival bring about consequential effects on the environment (Vithali, 2018; Wallace-Wells, 2019). In what looks like Newton's third law of motion, the action for the growth of the economy through the production of goods and services generates an equal reaction to environmental degradation, especially in the parts of the world, where there is little emphasis on environmental protection (Ogboru and Anga, 2015). In most developing countries especially, the burning of fossil fuels, gas flaring, electricity production, cement production, distribution and consumption, mining and other explorative activities, and reliance on alternative power supply through generators are some of the growth-generating economic activities. These activities are constant ways of emitting carbon dioxide (CO_2), which continues to have adverse effects on the environment, tending towards a catastrophic climate change and threat to the continuity of man (Pereira and Viola, 2018; Mckie, 2018; Kopits, Marten and Wolverton, 2013). The relationship between economic growth and with consequences of environmental pollution is the crux of the Kuznets hypothesis, which posits positive short-run nexus between the growth of an economy and environmental pollution and a negative long-run relationship between them (Kuznets, 1955; Stern, 2011).

EKC hypothesis is true in the case of many advanced countries as many of these countries, particularly in Europe and North America have adopted more environmentally-friendly technologies in carrying out most of their economic activities as well as championing the course for a pollution-free world thereby enhancement of quality climate and cleaner environment for all (Aghion et al., 2009; Martin & Vaitilingam, 2014). In contrast, most developing economies such as those in Latin America, Asia and Africa continue to increase environmental pollution with almost every increase in the production of goods and services (Bell & Russell, 2002). It is evident that these countries largely run their productions in a manner that creates as much pollution as value creations as they rely more on fossil fuel consumption, use of firewood for domestic cooking, heavy reliance on fuel-consuming modes of transportation, horizontal expansion in terms of housing development, with consequences on deforestation and by extension, emissions of carbon dioxide (Omoju, 2014; Adu & Denkyirah, 2017). This is generally not a good direction to follow as the future of humanity has been painted gloomy if there are no concerted efforts to cut the emissions of greenhouse gases.

Currently, evidence has shown that Carbon related emissions are responsible for about 75% of emissions of greenhouse gases and almost 80% of the emissions are generated from energy production and consumption, especially in developing countries (Akpan and Akpan, 2012). In recent times, the world has taken a common position to confront the issue of increasing environmental pollution, particularly the depletion of the ozone layer through the emissions of Greenhouse Gases, GHG, and (UN Climate Change Conferences 2009, 2010, 2014 and 2015). Given the attendant negative imports of economic activities on the environment, many studies have been undertaken to gauge the relationship between economic growth with environmental pollution. Notably, some studies established the validity of the EKC hypothesis in some countries (Ozturk and Acaravci, 2010; Lean and Smyth, 2010; Öztürk and Yildirim, 2015; Yahaya, Iro and Kabiru, 2019), some other studies could not confirm the hypothesis for other countries (Sulaiman and Abdul-Rahim, 2017). Yet, the study conducted by Eratas and Uysal (2014) established a somewhat N-shaped nexus between the variables in BRICT countries. Nigeria is among the industrializing countries in the Sub Sahara Africa with an economy that has been on the increase over time.

The growth of its economy has been premised mostly on energy production and exploration of crude oil with attendant environmental consequences in form of air pollution that is occasioned by gas flaring, among others, and oil spillages. Similarly, the release of carbon dioxide from cement production and construction of housing and infrastructure; carbon monoxide from vehicular operations through heavy reliance on road transportation, and nitrous oxide from nitrification and de-nitrification processes in agriculture, revealed that all sectors of the economy contribute to one way or the other to environmental degradation. The negative effects of the growth of the economy on the environment have been confirmed by Abdulrahim, Waziri, Huong and Ahmad (2014) and Akpan and Akpan (2012). However, it is worthy of note that all the studies conducted on the said relationship have focused on composite GDP as a proxy for economic activities, while none has attempted to disaggregate GDP into key sectoral components to investigate their individual effects on environmental degradation. In place of examining the aggregate effect of economic growth on environmental pollution, it will be helpful if policymakers have information on the contributions of each sector of the economy to pollution emissions.

This will provide room for more specific policy formulation to tackle the issues of the environment. In view of this, this paper investigates the contributions of key sectors of the economy (Agriculture, Construction, Industry, Services, and Trade) to environmental degradation proxied by CO_2 emissions. This is in a bid to first ascertain the existence or otherwise of long-run equilibrium between the GDP sectoral components and CO_2 emissions in Nigeria, and second, to examine the nature of the relationship, and determine which sector contributes most to environmental degradation. The outcome of this research will provide a guide to policymakers in identifying the sector that contributes the most to environmental pollution in a bid to encourage environmentally friendly technology in the sector, thereby promoting a cleaner environment and protection of the ecosystem at large. The latter parts of the paper are structured in the following manner. Section 2 reviews relevant literature, section 3 discusses the research methodology; while the estimation techniques were discussed in section 4. Section 5 considers the presentation and discussion of results, while the paper is concluded in section 6.

2. Literature Review

The well-being of man amidst limited natural resources has been a source of concern since ageless times. Many theoretical expositions have been made about the relationship between the consumption of natural resources, population growth and environmental degradation. For instance, Steiguer (1995) identified three economic theories, which provide a useful explanation of the environment. First is the population growth and resource scarcity by Thomas Malthus; second is the theory of steady-state economy by J.S. Mill, and third is the neoclassical economic theory of efficient markets as a solution to resource use and environmental problems. Kuznets (1955) added to the frontier of knowledge in the environment by formulating the Environmental Kuznets Curve hypothesis, which explains environmental pollution as the consequence of economic growth. The EKC theory is a common baseline theory for many research works in this area. Most studies have not only relied on its framework some others have attempted to verify the validity of its assertions in different climes. Akinlo (2009), Ozturk and Acaravci (2010), Alam, Begum, Buysse, Rahman, & Van Huylenbroeck (2011), Akpan and Akpan (2012), Sulaiman, Abdulrahim, Waziri, Huong & Ahmad (2014).

Demir, Cergibozan, and Gok (2018), and Yahaya, Iro and Kabiru (2019) are some of the studies that have been conducted to confirm the existence or otherwise of the EKC theory. Specifically, a similar study by Ang (2007) adopts energy consumption as an intervening variable in relation to France. The study specifically adopts vector error correction modeling (VECM) alongside the cointegration technique and affirms a fairly robust long-run relationship among the variables in the period between 1960 and 2000. In another study, Soytas, Sari, and Ewing (2007), also examine the dynamic nexus of CO_2 emissions with real output (which was proxied by energy consumption, labor and fixed capital) for the United States using time series data for the period between 1960 and 2004. It was concluded that only energy consumption and not GDP have a causal influence on CO_2 emissions in the long run. It was further revealed that gauging economic activities may not be the efficient solution for the reduction of emissions and other environmental challenges in the United States. In a related study, Ozturk et al. (2010) adopts the Autoregressive distribution lag (ARDL) bounds technique to test the nexus of economic growth with employment ratio, energy consumption and carbon emissions in Turkey. It was found that by adopting energy policies that reduce CO_2 emissions in the country, the real output of long-run growth may not be affected. The outcome of the studies by Soytas, Sari, and Ewing (2007) and Ozturk et al. (2010) is a positive affirmation of the existence of the EKC hypothesis for the US and Turkey.

Within the same period, Lean and Smyth (2010) employ annual times series data for Malaysia covering 1970-2008 to examine the dynamic nexus among economic growth, power generation, using exports as a control variable in a multivariate model. The results reveal the existence of one-directional causality running from economic output to power generation. By implication, efficient management of power consumption and conservation can be achieved without hindering the economic growth process. On a broader perspective,Erataş and Uysal (2014) conducted a similar study on BRICT countries and adopting Panel Cointegration techniques, they find an N-shaped relationship as against an inverted U-shaped relationship hypothesized by Kuznets. Similarly, the EKC hypothesis has also been positively affirmed by studies conducted by Baek (2015) and Öztürk and Yildirim (2015) on Arctic and MINT countries, respectively. Conversely, Sulaiman and Abdul-Rahim (2017) conducted a similar study using a 3-way linkage approach in addition to the ARDL model. The study finds that both carbon dioxide emission and energy variables have no significant effect on the performance of the Malaysian economy. Furthermore, they reveal a reverse case for CO_2 emissions, which they find to be positively and significantly dependent on energy consumption and economic growth. The study outcome invalidates the Kuznets hypothesis for Malaysia. In an innovative twist and more recently, Demir, Cergibozan, and Gok (2018) adopted the ARDL approach alongside secondary data for the period 1963-2011 to examine how income inequality affects carbon dioxide emissions in Turkey.

It was revealed in the results that carbon dioxide emissions are inversely related to income inequality, in which case, an increase in income inequality leads to a reduction in carbon emissions. Also, in their contribution to the EKC hypothesis, Zaidi, Zafar, Shahbaz, and Hou, (2019), innovatively examine how globalization and financial development relate to carbon emissions in APEC countries. The study which covered 1990-2016 adopts Westerlund (2007) cointegration technique alongside Continuously Updated Bias-Corrected (CUP-BC) as well as Continuously Updated Fully-Modified (CUP-FM) methods to gauge the long-run elasticities among the variables. It was found that carbon emissions are significantly reduced by both globalization and financial development, whereas, the emissions are increased by increasing economic output and higher energy use. The outcome is another testimony to the EKC hypothesis. In Nigeria, studies have also been conducted on the relationship between economic performance with environmental pollution. One of the recent studies by Akpan and Akpan (2012) adopt the Autoregressive distributed lag (ARDL) technique on secondary data from 1970-2008. The study's long-run results reveal that increasing economic output brings about an increase in carbon emissions, which invalidates the Kuznets hypothesis for Nigeria. Conversely, Sulaiman, Abdulrahim, Waziri, Huong & Ahmad (2014) examine the relationship between energy consumption with carbon dioxide emissions alongside economic output. The study adopts the ARDL approach and reveals that a long-run relationship exists among the variables.

The study by Sulaiman et al. (2014), unlike Akpan and Akpan (2012), validates the Kuznets hypothesis for Nigeria. In a more recent study, Yahaya, Iro and Kabiru (2019) brought a twist to the study of economic performance and environmental pollution by examining the influence of fossil fuel consumption on carbon dioxide emissions in Nigeria using economic output, financial development and foreign direct investment as control variables. The study reveals that both in the current and future periods, CO_2 emissions are increased both significantly and positively by the explanatory variables. By implication variables of economic growth and development have the capacity to increase carbon dioxide emission in Nigeria in the short run only. In summary, all the studies reviewed above-considered GDP in its aggregate form as a proxy for economic growth, while few of them paid specific attention to the short-run and long-run relationship to verify the EKC hypothesis. Therefore, attempts will be made in this study to examine the differential effects of sectoral contributions of GDP components on environmental pollution in Nigeria to identify the contributions of each sector to CO_2 emissions.

3. Research Methodology and Model Specification

In achieving the objective of investigating the effect of key sectors of Nigeria's economy on environmental degradation, times series data on key sectors of the economy (Agriculture, Industry, Construction, and Services) for the period 1981-2018 were employed in the study. Meanwhile, time series data on the population for the same period was also adopted as an intervening variable. The Autoregressive distributed lag (ARDL) method was adopted to conduct data analysis, while the data analyzed were obtained from the Statistical Bulletin of the Central Bank of Nigeria (2018). This method of estimation was adopted because: first, it can be applied to variables that are of the same or different integration orders, that is, I(0) or I(1) or a combination of both. For instance, Engle and Granger (1987) and Johansen and Juselius (1990) approaches required that variables are of the same order of integration. Second, the ARDL estimation technique makes it possible for short-run and long-run coefficients of independent variables to be obtained simultaneously. Third, the ARDL technique is suitable to produce estimates for a small sample size. All the variables in this study were log-linearized for uniformity and ease of analysis. The underlying theory for this study is the Environmental Kuznets Curve theory, which established a relationship between the growth of the economy and environmental degradation. It hypothesizes a positive short-run relation and a negative long-run equilibrium between the variables. This implies that in the long run, increasing economic output is expected to bring about a reduction in environmental degradation. In achieving the objective of the study, the growth of the economy was proxied by GDP, which was disaggregated into its key sectors, while environmental degradation was proxied by carbon dioxide emissions.

The linear construct between environmental pollution and increasing economic output can be represented mathematically as below:

$CO_2 = f(GDP)$ 3.1

The econometric form of model 3.1 is given as:

$CO_{2_t} = \beta_o + \beta_1 GDP_t + \varepsilon_t$ 3.2

Where: CO_{2_t} is carbon dioxide emission at time t, β_o and β_1 are the intercept and coefficient of the explanatory variable, respectively.

GDP is the explanatory variable at time t that explains the changes in CO_2.

To suit the purpose of this study, which seeks to examine the effects of sectoral contributions to GDP on CO_2 emissions, model 3.2 is decomposed as follows:

$CO_2 = f(AGR, CONS, IND, SEV, POP)$ 3.3

Where: CO_2, AGR, CON01, IND, SEV, POP denotes Carbon dioxide emissions, Agriculture, Construction, Industry, Services, and Population, respectively.

Expressing equation 3.3 in a stochastic form, we have:

$CO_{2_t} = \beta_o + \beta_1 AGR_t + \beta_2 CON01_t + \beta_3 IND_t + \beta_4 SEV_t + \beta_5 POP_t + \mathcal{E}_t$ 3.4

The log-linearized form of model 3.4 is:

$LNCO_{2_t} = \beta_o + \beta_1 LNAGR_t + \beta_2 LNCON01_t + \beta_3 LNIND_t + \beta_4 LNSEV_t + \beta LN_5 POP_t + \mathcal{E}_t$ 3.5

Estimation Techniques

Unit Root Test: The starting point in adopting time series data for regression analysis and prediction is to verify the presence of non-stationarity property in the data. This is because any estimation using non-stationary data will generate spurious regression, and cause the model to lose its predictive power. In this study, a unit root test for stationarity was conducted for all the variables of interest to identify the presence or otherwise of stationarity and ascertain the order of integration. This is because the use of ARDL may be invalidated by the presence of any variable that is integrated of order 2. Consequently, the study adopted unit root test methods suggested further confirmed by the approach suggested. The Augmented Dickey-Fuller (ADF) approach was carried out within the framework of the equation specified as model 4.1 below:

$$\Delta Y_t = \vartheta + \theta_1 t + \delta Y_{t-1} + \theta_i \sum_{i=1}^{k} \Delta Y_{t-1} + \varepsilon_t \qquad 4.1$$

Where ϑ is a constant, t is the time trend, while $\mathcal{E}_t$ is the error term. The term Y_{t-1} is the lagged value of the series Y. The equation is a time and trend specification form for the Augmented Dickey-Fuller unit root test using the Autoregressive Moving Average (ARMA) structure of the errors in the regression. The Phillips Perron (PP) test, which ignores serial correlation is often specified using the equation below:

$$\Delta Y_t = \vartheta + \beta' t + \pi Y_{t-1} + \varepsilon_t \qquad 4.2$$

In this case, $\mathcal{E}_t$ is of integrated order zero, I(0) and maybe heteroskedastic (Obioesio, 2015).

Table 1: Unit Root Test Result

	AUGMENTED DICKEY-FULLER TEST (ADF)		**PHILLIPS-PERRON TEST (PP)**		**Order of Integration**
Variables	**t-stat**	**P-Values**	**t-stat**	**P-Values**	
$LNCO_2$	-1.931064	0.3150	-1.931064	0.3150	
LNAGR	0.024076	0.9549	0.025613	0.9550	
LNCON01	-0.183950	0.9316	0.225256	0.9706	
LNIND	-0.769567	0.8159	-0.671535	0.8416	
LNSEV	0.360042	0.9783	0.851893	0.9936	
LNPOP	-3.182240*	0.0311	0.285391	0.9743	I(0)
$\Delta LNCO_2$	-6.085137*	0.0000	-6.085137*	0.0000	I(1)
ΔLNAGR	-5.850647*	0.0000	-5.849978*	0.0000	I(1)
ΔLNCON01	-3.440588*	0.0159	-3.359901*	0.0193	I(1)
ΔLNIND	-5.547051*	0.0000	-5.670457*	0.0000	I(1)
ΔLNSEV	-3.104838*	0.0351	-2.960076*	0.0485	I(1)
ΔLNPOP	-4.710111*	0.0005	-4.734679*	0.0005	I(1)

Source: Authors' computation, (2019) using E-views 9.0
Note: Δdenotes first difference variables. *Denotes rejection of the null hypothesis of unit root at a 5% level of significance. The lags are selected automatically based on the optimal lag length selection of the SIC criteria; t-stat denotes t-statistic.

ARDL Bounds Test for Cointegration: It is usually necessary to check the existence of 0long-run equilibrium or relationship between the variables. In performing the bounds test for cointegration, the conditional ARDL (p, q1, q2, q3, q4, q5, q6) model with 6 variables is specified as:

$$\Delta LNCO_{2_t} = \delta_{01} + \beta_{11} LNCO_{2_{t-i}} + \beta_{21} LNAGR_{t-i} + \beta_{31} LNCON01_{t-i} + \beta_{41} LNIND_{t-i} + \beta_{51} LNSEV_{t-i} + \beta_{61} LNPOP_{t-i} + \sum_{i=1}^{p} \gamma_{1i} \Delta LNCO_{2_{t-i}} + \sum_{i=1}^{q} \gamma_{2i} \Delta LNAGR_{t-i} + \sum_{i=1}^{q} \gamma_{3i} \Delta LNCON01_{t-i} + \sum_{i=1}^{q} \gamma_{4i} \Delta LNIND_{t-i} + \sum_{i=1}^{q} \gamma_{5i} \Delta LNSEV_{t-i} + \sum_{i=1}^{q} \gamma_{6i} \Delta LNPOP_{t-i} + \varepsilon_{1t}$$

Equation 4.3

$H_o: \gamma_{1i} = \gamma_{2i} = \gamma_{3i} = \gamma_{4i} = \gamma_{5i} = \gamma_{6i} = 0$ (no cointegration exists)

$H_1: \gamma_{1i} \neq \gamma_{2i} \neq \gamma_{3i} \neq \gamma_{4i} \neq \gamma_{5i} \neq \gamma_{6i} \neq 0$ (cointegration exists), where *i* = 1, 2, 3, 4, 5 & 6).

Table 2: The Results of the ARDL Cointegration Test

Dependent Variable: DLNRGDP		
Function: F_{DLNCO2}(DLNCO$_2$|DLNAGR, DLNCON01, DLNIND, DLNPOP, DLNSEV)		
F-Stat (5) = 6.859237		
Asymptotic Critical Values (n =1000)*	I(0)	I(1)
10%	2.26	3.35
5%	2.62	3.79
2.5%	2.96	4.18
1%	3.41	4.68

*The critical values for the lower I(0) and the upper I(1) bounds were obtained from Pesaran, Shin, and Smith (2001). **Source:** Authors' computation (2019) using E-views 9.0.

In conducting cointegration using the ARDL technique, the selection of optimal lag length is an important step to take; hence, Akaike Information Criterion was considered for this purpose. The optimal lag length that was produced lag length analysis is 3 for CO_2, AGR, and SEV, while the optimal lag length for CON01, IND, and POP are 2, 1,0 0, respectively in the model. The ARDL cointegration test results, obtainable in Table 2 revealed that the calculated F-statistic of F (CO_2|AGR, CON01, IND, SEV, POP) exceeds the upper critical value. Hence, the results affirm the presence of a long-run relationship between the variables at a 5% significance level in Nigeria over the 1981–2018 period.

The Long Run Coefficients Estimates: Having ascertained the presence of long run nexus between the variables, it is necessary, in line with the stated objectives, to examine the Environmental Kuznets Curve theory for both the short run and the long run relationships among the variables. This study adopted the Error Correction Mechanism (ECM) form of the ARDL model. The ECM estimates the speed at which a dependent variable converges to equilibrium after a change in other variables. The ECM model representing equation 4.3 is specified below:

$$\Delta LNCO_{2_t} = \delta_0 + \sum_{i=1}^{p} \omega_i \Delta LNCO_{2_{t-i}} + \sum_{i=1}^{q} \gamma_{1i} \Delta LNAGR_{t-i} + \sum_{i=1}^{q} \gamma_{2i} \Delta LNCON01_{t-i} + \sum_{i=1}^{q} \gamma_{3i} \Delta LNIND_{t-i} + \sum_{i=1}^{q} \gamma_{4i} \Delta LNSEV_{t-i} + \sum_{i=1}^{q} \gamma_{5i} \Delta LNPOP_{t-i} + \alpha ECT_{t-1} + \varepsilon_t$$

Equation 4.4,

Where Δ represents the first differenced variable, $\mathcal{E}_t$ represents the residual error term that is assumed to be iid with zero mean and constant variance; α is the coefficient of the error correction term; while ECT is the term that measures the speed of adjustment between the short and long-run relation. The ECT_{t-1} is expected to have a negative sign, while it must be statistically significant at the same time to affirm the existence of a long-run relationship between carbon dioxide emissions and the key sectors of Nigeria's economy.

Diagnostic Tests after Cointegration: In checking the robustness of the ARDL model, the study conducted some diagnostic tests. This is also for checking the reliability, consistency and efficiency of the model and coefficients. For this purpose, serial correlation test, heteroskedasticity test, normality test, functional form test, and stability tests via CUSUM and CUSUMSQ were carried out.

4. Results and Discussion

Error Correction Mechanism (ECM) model estimates were obtained from the regression of model 4.4 above. The motive of this study is to specifically examine the respective contributions of the key sectors of the economy to environmental degradation within the purview of the EKC hypothesis. For this reason, the short and long-run ARDL results are presented in Table 3. This provides an opportunity to examine the alignment of Nigeria's economic growth (in particular, the sectors) with the EKC hypothesis. The results are presented below:

The Estimated Long Run and Short Run ARDL Model

Table 3: Long Run and Short Cointegration Equations

Variable	Coefficient	Std. Error	t-Statistic	Prob.
Short Run Coefficients				
D(LNCO$_2$(-1))	-0.448081	0.215461	-2.079639	0.053
D(LNCO$_2$(-2))	-0.506076	0.205834	-2.458659	0.025
D(LNAGR)	0.586301	0.308079	1.903084	0.0741
D(LNAGR(-1))	0.48932	0.397057	1.232369	0.2346
D(LNAGR(-2))	-0.59135	0.254574	-2.322898	0.0328
D(LNCON01)	0.476517	0.365156	1.304971	0.2093
D(LNCON01(-1))	0.354884	0.243407	1.457983	0.1631
D(LNIND)	0.885405	0.281207	3.14859	0.0059
D(LNPOP)	-1.14205	0.678991	-1.681983	0.1108
D(LNSEV)	-1.788897	0.607288	-2.945714	0.009
D(LNSEV(-1))	-0.757815	0.868629	-0.872426	0.3951
D(LNSEV(-2))	-0.775687	0.532198	-1.457516	0.1632
ECT(-1)	-0.673796	0.18111	-3.720371	0.0017
R^2	0.929305			
Adjusted R^2	0.858611			
DW Stat	2.2160581			
Long Run Coefficients				
LNAGR	0.911055	0.488686	1.864296	0.0796
LNCON01	0.644372	0.402126	1.602415	0.1275
LNIND	2.901744	0.862325	3.365022	0.0037
LNPOP	-1.69495	1.331999	-1.272485	0.2203
LNSEV	-1.754922	0.662578	-2.648628	0.0169
C	13.467698	16.211623	0.830743	0.41176

Source: Authors' computation (2019) using E-views 9.0.

The ARDL regression outcomes revealed that it is not all the key sectors of the Nigerian economy that are statistically significant in explaining the variation in environmental degradation, which was measured using CO_2 emissions. Precisely, construction (CONS01) was found to not have any significant impact on carbon dioxide emissions. Further results reveal that in the short run, the agricultural sector in its current and lag one periods has no significant effect, however, the lag two period of the agricultural sector and the services sector show statistical significance with a negative impact on carbon dioxide emissions which invalidates the EKC short run hypothesis; hence, they do not increase carbon dioxide emissions. Meanwhile, the industrial sector confirms the EKC hypothesis for Nigeria with a statistically significant positive relation with CO_2 emissions. Time series data on the population for the same period was also adopted as an intervening variable. The Autoregressive Distributed Lag (ARDL) approach was adopted from estimation, while data were obtained from the Central Bank of Nigeria's Statistical Bulletin (2018). This means that, the higher the industrial output, the higher the CO_2 emitted into the environment. The ECM model demonstrated acceptable signs, which were both negative and statistically significant.

The ECT result also confirmed the existence of a long-run equilibrium between the time series variables. It also showed that the disequilibrium in the short run will converge in the long run at the rate of 67.37 percent annually. In the long run, however, the agricultural and construction sectors still showed a positive relationship to carbon dioxide emissions, though they are not statistically significant. The industrial sector is statistically significant with a positive effect on CO_2 emissions, which means that in the long run, higher industrial outputs will bring about higher environmental degradation. Although this is against the EKC hypothesis, it is a cause of concern for policymakers in Nigeria. Lastly, the services sector appears to be a hopeful future driver of the Nigerian economy as it is both statistically significant and showed a negative relationship with carbon dioxide emissions. This is an empirical confirmation of the Environmental Kuznets Curve theory, which postulates that in the long run, the growth of the economy will be negatively related to environmental degradation. The import of the findings of this study is that Nigeria as a country should focus more on economic growth from the services sector while advocating for cleaner and environmental-friendly technologies in other sectors of the economy.

Presentation of the Robustness Check and Diagnostic Tests Results: Despite the significance of the econometric model and the empirical confirmation of the relationship between environmental degradation and the key sectors of Nigeria's economy, it is necessary to check the robustness of the model through the diagnostic tests, which are reported hereafter.

Table 4: Serial Correlation Test

Breusch-Godfrey Serial Correlation LM Test:			
F-statistic	0.603508	Prob. F(1,16)	0.4486
Obs*R-squared	1.272187	Prob. Chi-Square(1)	0.2594

Table 5: Heteroskedasticity Test

Heteroskedasticity Test: Breusch-Pagan-Godfrey			
F-statistic	2.001274	Prob. F(17,17)	0.0814
Obs*R-squared	23.33829	Prob. Chi-Square(17)	0.1386
Scaled explained SS	8.839076	Prob. Chi-Square(17)	0.9452

Figure 1: Jarque-Bera Test for Normality

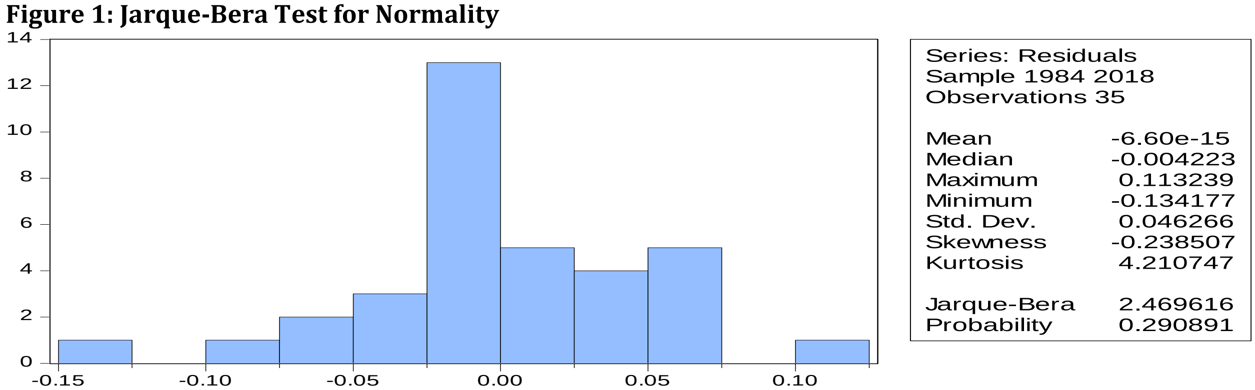

Figure 2: Plot of CUSUM and CUSUMSQ Tests for the Parameter Stability

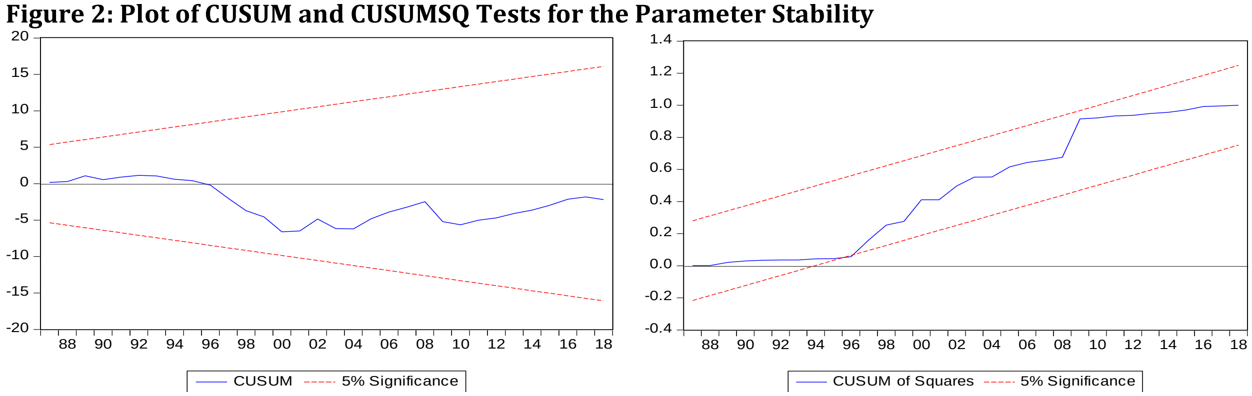

Table 6: Omitted Variable Test Result

Omitted Variables: RESIDSQ	**Value**	**DF**	**Probability**
t-statistic	0.947929	16	0.3573
F-statistic	0.898569	(1, 16)	0.3573
Likelihood ratio	1.912409	1	0.1667

Considering the test of goodness of fit, it was revealed that the R-Squared of the model is 92.9 percent. This means that within the context of the Nigerian economy, the key sectors and the economy and population as an intervening variables can explain 92.9 percent of the total variation in CO_2 emissions. The Adjusted R-Squared of the same model revealed the explanation of total variation between the variables to be about 85.86 percent. Further than that, the diagnostic test results show that there are no problems relating to serial correlation, heteroskedasticity, misspecification and normality of the residuals in the econometric model as shown in the results presented earlier. More so, the results of the CUSUM and CUSUMSQ tests as presented in Figure 2 show that the estimated coefficients fall within the acceptable critical bounds of 5% significance. By implication, the estimated parameters are found to be stable over the period of the study.

5. Conclusion and Recommendations

This study has revealed various results of the relationship between key sectors of Nigeria's economy and environmental degradation in line with the Environmental Kuznets Curve (EKC) hypothesis. The theory predicted a positive relationship between economic growth and environmental degradation in the short run, while it also predicted a negative relationship in the long run. This study reveals that it is not all the sectors of Nigeria's economy that contribute to environmental degradation in Nigeria. Specifically, attention should be paid to Agriculture, Services and Industrial sectors. It is expected that any country that is growth-focused will bother less about environmental pollution and degradation in the short run. This is a fallout of the EKC hypothesis. Therefore, more emphasis should be placed on the long-run relationship, where a negative relationship is expected between the growth of the economy and environmental pollution. It is therefore recommended that policymakers in Nigeria should focus more on the agricultural and industrial sectors, which were not only statistically significant but also showed a long-run positive relationship with environmental pollution, against the EKC hypothesis.

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