

Empirical Analysis of the Environmental Kuznets Curve for CO₂ Emissions in Nigeria: The Role of Industrialization and Urbanization

Emmanuel O. Okon

Dept of Economics Kogi State University Kogi State, Nigeria

Email: tonydom57@yahoo.com

Article History

Received: November 10, 2020

Revised: December 15, 2020

Accepted: December 18, 2020

Published: December 22, 2020

Abstract

The proposed inverted U-type relationship between environmental degradation and per capita income under EKC hypothesis has been examined in this paper for Nigeria over the period 1970-2019. Using the ARDL bounds testing approach to cointegration and ECM (OLS Approach), the EKC hypothesis does not seem to hold both in short-run and long-run. The estimated coefficients of the long-run relationship shows that LOGCO2(-1) is the only statistically significant variable explaining environmental degradation while the short run results indicate that D(LOGCO2(-1)) is the most significant variable in explaining environmental degradation in Nigeria followed by D(LOGIND(-1)).

Keywords: Carbon dioxide emissions per capita; Industrialization; Urbanization; EKC; ARDL bounds testing; ECM (OLS Approach).

1. Introduction

The development of economic wealth of countries, whether regions or be it communities with the specific interest in making the inhabitants comfortable is called economic development (Svbic, 2011). As far as underdeveloped countries are concerned, the essential position played by industrialization cannot be ignored. Historically, the world's developed countries have dismantled poverty's vicious cycle through the medium of industrialization as against devoting attention primarily on agricultural or entirely focusing on national resources production (Owlcation, 2018).

Basically, industrialization is the power house of urbanization. Via economic growth and job opportunities, industrialization culminates in urbanization due to attraction of people from nooks and crannies into cities (Investopedia, 2018). Undeniably, as far as industrialization goes, cities are the important land for it to thrive. Industrialization and urbanization can be likened to biological brothers that grow and develop side by side and at the same time nurture each other (Lexicon Universal Encyclopedia, 1997).

Industrialization can be categorically called urbanization initiator; on the other hand, the inevitable outcome of industrialization is urbanization. The period of late 1800s and early 1900s witnessed inventions of railroad tracks, automobiles, telephones, airplanes and electricity. These were all part of industrialization, the spring up of cities and urbanization eventually (123HELP ME, 2018).

In the attempt to cut back on time and cost by individual and corporate efforts mostly especially in commuting and transportation while improving opportunities for jobs, education, housing, and transportation, this naturally brings about urbanization.

The expanding population density and urban environments demands exacerbates poor air and water quality, and insufficient water availability. It also cause waste-disposal challenges, and high energy consumption. Nonetheless, economic development through rapid industrialization along with growing environmental consciousness have sparked a serious debate on how economic development (or growth) is linked with environment.

Much discussion was evoked regarding the connection of environmental quality with economic development in the recent past decade (i.e., 1990s). Cross-sectional evidences across countries were put forward by the World Development Report (World Bank, 1992) regarding the relationship between different indicators of environmental quality and per capita national income. An inverted U-shaped relationship between environmental degradation and income have been documented by other studies like (Grossman and Krueger, 1991; Rothman, 1998; Selden and Song, 1994; Suri and Chapman, 1998). The bottom line of all these previous studies is the assertion that initially, environmental degradation increases till it reaches a maximum level and after that declines as an economy develops. This systematic inverted-U relationship has been described as the Environmental Kuznets Curve (EKC). This followed the work of Kuznets (1955), who postulated a similar relationship between income inequality and economic development.

Although, the EKC relates to the issue of the impacts of economic growth or development on the environment of a country, however, some are of the opinion that industrialization and urbanization at a point result in environmental degradation (Peng and Bao, 2006).

This paper contributes to the literature by empirically examining the relationship between industrialization, urbanization and environmental degradation from the EKC point of view with a spotlight on Nigeria. This is because the pattern, trend, and characteristics of urbanization in the country have been alarming. According to Egunjobi (1999), the towns and cities have grown so remarkably with urbanization rate exhibiting extraordinary high rates of 5%–10% per annum.

Accordingly, Nigerian cities’ area have shown huge expansion 10-fold away from their initial point of growth (Agbola and Agbola, 1997). This tremendous growth as observed by Egunjobi et al. (2002) has been so unplanned and uncontrolled. The high urban growth in Nigeria has created numerous problems and challenges. More certainly noticeable and maybe extremely alarming are the general human and environmental poverty, the declining quality of life and the underutilized along with the untapped wealth of human resources. Following this introduction that contains review of empirical studies, section II provides an overview of industrialization and urbanization in Nigeria as well as the environmental problems faced. Section III describes the methodology in terms of model specification in addition to data and technique of analysis. The empirical results are reported and discussed in section IV. Section V is summary, conclusion and recommendations.

2. Overview: Industrialization and Urbanization in Nigeria

Different cities of importance and sizes existed in Nigeria prior to the colonial period. Examples of such cities are Lagos, Ibadan and Ilorin, in the south western region, Kano and Zaria, in the northern part, and Onitsha and Aba, in the eastern area, as well as Port Harcourt and Calabar in the south. The forenamed are completely in conjunction with their distinguishing socio-cultural identities even as they are locations occupied by the three major ethnic groups in Nigeria, plus the southern sub-ethnic group, respectively (Oni-Jimoh and Liyanage, 2018). The rural-urban migration rate of people was actually low around this era mostly because agriculture as an occupation was the main focus of majority of people.

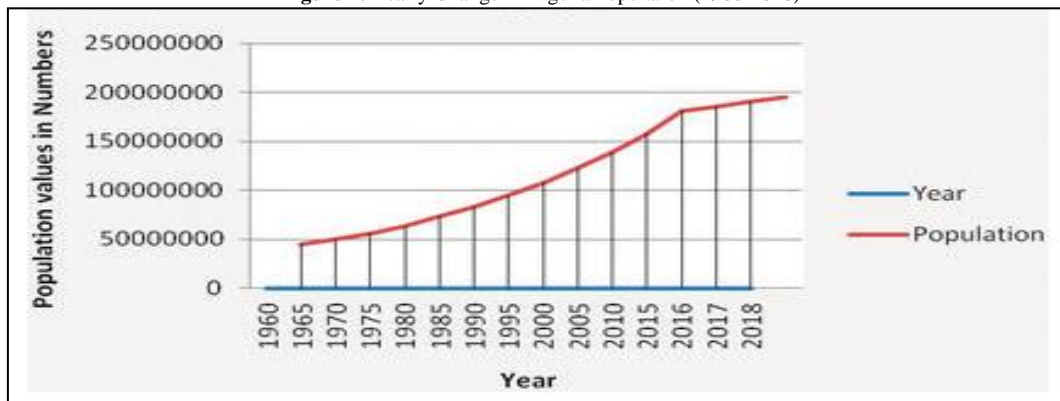
Nigeria has metamorphosed to an increasing extent an urbanized and urban-oriented society since independence. Basically, this was prompted by the oil boom prosperity of the 1970s and the mammoth advancement in roads and the accessible of vehicles (Photius, 2005). In a similar manner, NREH (2017), reported that the expeditious expansion of urban population rate of Nigeria is attributed to the 1970s oil boom success and aftermath immense development projects in mostly parts of the country which encourage a substantial inflow of people into urban areas (NREH, 2017).

In comparison with the rest of the world, the swiftest urbanization growth rate during the 1970s was experienced by Nigeria. Due to the immense inflow of people especially into the urban areas, Nigeria’s urban population growth rate in 1986 was estimated to be approximately 6 % annually, in excess of twice that of the rural population (Photius, 2005). Between the period 1970 and 1980, the estimated percentage of Nigerian living in urban areas was had risen from 16 to more than 20%. The urban population by 2010 was anticipated to exceed 40 % of the nation's total (Photius, 2005). Interestingly, Nigeria’s urban population has become larger from 6.9 million, 15.4% of the total population of 45 million in 1960 to 99.9 million, that is to say 48.9% of the total population of 195.8 million in 2018 (Dover, 2018) (see Figure 1 and 2).

Nigeria is regarded as one of the most populous countries in the world with numerous cities boasting populations exceeding one million. Lagos is the biggest city and it contributes 9 million residents to the total population. In addition, there are 79 cities having a minimum population of 100,000. Furthermore, there are 249 cities with populations surpassing 10,000 (World Population Review, 2019). Another fact about Nigeria is that it has a total of 36 states, and 774 Local Government Areas. These LGAs are spread across the nation. It is worthy of noting that different states in Nigeria in their own capacity have contributed to the country’s growth in several sectors, but here are some of the most industrialized states that have driven Nigeria’s growth:

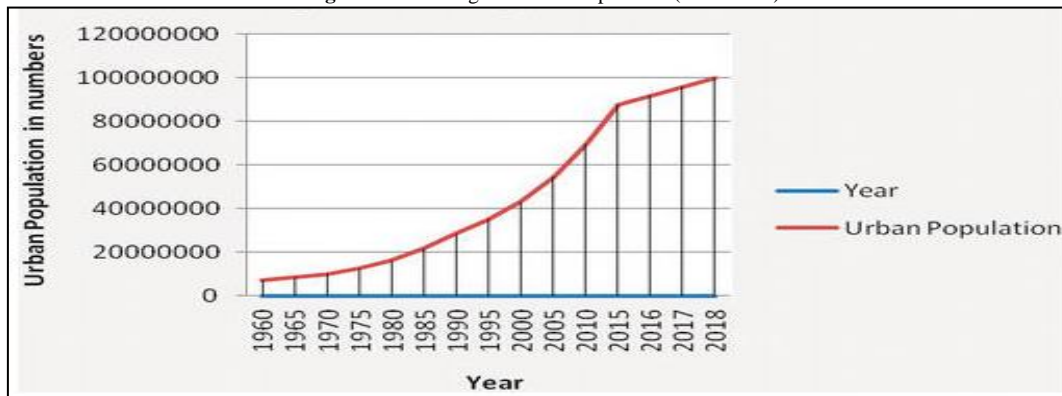
Among the vast urban dwelling in Nigeria and in the continent of Africa is Lagos state. It is responsible for over 60% of industrial and commercial activities in the nation as a whole. Headquarters of virtually the entirely companies located in Nigeria are found in Lagos.

Figure-1. Yearly Change in Nigeria Population (1960-2018)



Source: Oni-Jimoh and Liyanage (2018)

Figure-2. Percentage of Urban Population (1960-2018)



Source: Oni-Jimoh and Liyanage (2018)

Financially, Lagos state is strong and self-sustaining. Over 75% of its revenues is single-handedly generated away from federal grants originate in oil revenues. Among all the states in Nigeria, it can be categorically stated that Lagos has the highest internally generated revenue

The centre of Nigeria's oil industry is River state - popularly called treasure base. With a population of about 7,303,924 and a total area of 11,077 km² (4,277 mi²), it stands out as the 26th largest state in Nigeria (Gbaradi, 2018). Undeniably, the state is renowned mostly for its crude oil and natural gas mega reserves. It has two major oil refineries, two major seaports, airports, and various industrial estates spread across the land. It is not surprising that crude oil produced in the state alone is more than 60% of the country's total output. In addition, silica sand, glass sand and clay are other natural resources endowment of the State.

Another oil-rich and agricultural producing state is Delta state. Generally, the state is described as the "big heart". It spans about 18,050 km² landmass; populated with about 5,663,362 people (Gbaradi, 2018); and precisely located in the south-south region of Nigeria. The State is one of the distinctively developed and captivating states in Nigeria. It is blessed with renewable energy in addition to oil production with a GDP of \$16.75 billion as at 2007 successfully putting it as the third richest state in Nigeria after Lagos and Rivers state (Gbaradi, 2018).

Also, among the most industrialized states of Nigeria is Oyo State. The pacesetter State is renowned for its cottage industries which consist of cotton spinning, weaving, together with dyeing and leatherworking (sheep and goat skins). It also includes wood carving and mat making. Agriculture and handicrafts are the thrust of Oyo state's economy. In terms of industries, the key ones are tire-retreading, cigarette manufacturing and the processing of agricultural products. Flour-milling, leather-working and furniture-making are inclusive.

Furthermore, Kano State is an equally populated state in Nigeria. It referred to as the centre of commerce. This is mainly because of its geographical advantageous point for commercial activities in neighbouring West African Countries such as Republic of Niger, Chad, Cameroon, Benin, Burkina Faso and Senegal. In connection with Nigeria's territorial land mass, it specifically occupies 20,280 Sq. Km. Pertaining to the northern region of Nigeria, Kano State is the largest with textile, tanning, footwear, cosmetics, plastics, enamelware, pharmaceuticals, ceramics, furniture and other industries. In 2016, the internally generated revenue of the State stood at N18 billion (Gbaradi, 2018).

2.1. Environmental Problems of Nigeria

The stage of development, economic structure alongside production technique in use defines a nation's environmental challenge. It is also, a function of its environmental policies.

Undoubtedly, Nigeria perpetually experience the bane of inadequate sanitation and clean drinking water, following the pursuit for industrialization and western developed countries steadily clustering industries in Nigeria, air and water pollution is now order of business (Tyler, 2000). Atmospheric pollution is the outcome of urbanization which is the accompanying footprint of economic development and industrial expansion. In big cities, vehicular traffics escalation is identified as the prime source of air pollution. Other originators comprise two stroke engines, old vehicle, traffic jam, deplorable roads and outdated automotive technologies and poor traffic management system. The industrial pollution complication is profound in places where chemicals, petroleum refineries along with iron and steel industries are located. Likewise, it is drastic in areas clustered with non-metallic products, pulp and paper and textiles industries. Equally, small scale industries such as foundries, chemical manufacturing and brick making are notably air polluters (Adejoh, 2011).

Thermal power generation plant is an additional crucial source of air pollution. On grounds of African countries quest for industrialization and globalization's aftereffect, air pollution has turned out today to be a key environmental problem. Transport is responsible for approximately 50% of urban air pollution in industrialized nations of the West according to Oluwole *et al.* (2005). Relatively speaking, the out-turn of Lagos ambient particulate portrays transportation as constituting 15% of the particulate while the contribution to gaseous pollutant in Lagos is far more (>80% in parts of Lagos) (Oluwole *et al.*, 2005).

Immense freshwater resources of Nigeria are amidst the utmost stricken by environmental strain meted out by human population growth, urbanization, and industrialization. Presently, a critical environmental issue in Nigeria is waste disposal and management. The popular technique of waste disposal employed in the country are land filling, dumpsites and land spreads. Others are water disposal and incineration.

By reason of their prospects to pollute and defile underground and surface water bodies in the country, each and every one of these methods has far-reaching implications for the environment (Adeyemo, 2003). Furthermore, absence of environmental control of water-dependent activities (including domestic, agricultural, and industrial) plays an essential role in the severe water pollution crises experienced in major cities in Nigeria.

3. Methodology

3.1. Model Specification

As stated by Grossman and Krueger (1991), Panayotou (1997), De Bruyn (2000), among others, the generalized functional form of the equation to test the EKC is presented as follow:

$$Y_t = \beta_0 + \beta_1 X_t + \beta_2 X_t^2 + \beta_3 X_t^3 + \varepsilon_t \tag{1}$$

Where: Y= environmental degradation (pollutant); X= GDP per capita; X² = square of GDP per capita ; X³ = cube of GDP per capita; β₀ = the constant or the intercept; β₁ - β₃ = the coefficients of the explanatory variables; t= time; ε=Error term.

The quadratic expression of the above model is as follows:

$$CO_{2t} = \beta_{0t} + \beta_{1t}GDP + \beta_{2t}GDP^2 + \phi_t \tag{2}$$

In this paper, an expanded form of the model employed to explore the influence of industrialization and urbanization on environmental quality in Nigeria is presented as follows:

$$CO_{2t} = \beta_{0t} + \beta_{1t}GDP + \beta_{2t}GDP^2 + \beta_{3t}URB + \beta_{4t}IND + \phi_t \tag{3}$$

Where: CO₂ = CO₂ emissions per capita; GDP = GDP per capita (current LCU); GDP² = Squared GDP per capita (current LCU); IND = Industry, value added (current LCU); URB = urbanization (Urban population (% of total))

The quadratic specification of model was actually converted into double log form base on the ground that log specification yields far more suitable and systematic outcome as against simple quadratic functional form of model (Cameron, 1994; Ehrlich, 1995). Furthermore, logarithmic form of variables gives direct elasticities for interpretations. Therefore, estimable equation in double-log form is specified thus:

$$\text{LogCO}_{2t} = \beta_{0t} + \beta_{1t}\text{LogGDP} + \beta_{2t}\text{GDP}^2 + \beta_{3t}\text{LogURB} + \beta_{4t}\text{LogIND} + \phi_t \tag{4}$$

The expected signs of the coefficient of the explanatory variable are: β₁>0, β₂<0, β₃>0, β₄>0

The values of the parameters, if the EKC hypothesis is valid, should be positive for β₁ and negative for β₂. The squared term in the model indicates the U-shape behavior of the EKC. If β₁>0 and β₂<0, an inverted U-shape relationship is inferred. The turning point income T, where CO₂ emission is supposed to be at its maximum, can be inferred in the following way (Stern, 2004):

$$T = \exp (-\beta_1 / 2\beta_2) \tag{5}$$

3.2. Data and Technique of Analysis

The data for the series employed were sourced from Index Mundi data portal. The period 1970 to 2019 was covered. The choice of the starting period was constrained by the availability of data. In determining the stationary properties of the series (variables), the Augmented Dickry-Fuller test was deployed. Furthermore, this paper explores the Autoregressive distributed-lag models (ARDL) Bounds testing approach to cointegration under a conditional Error Correction Model(OLS Approach) framework. The bound test (ARDL) is actually a test for co-integration among the series integrated of different orders less than I(2) while the Error Correction Model (ECM) links the long-run equilibrium relationship among the time series implied by cointegration with the short-run dynamic adjustment mechanism. In its basic form, an ARDL regression model looks like this:

$$y_t = \beta_0 + \beta_1 y_{t-1} + \dots + \beta_p y_{t-p} + \alpha_0 x_t + \alpha_1 x_{t-1} + \alpha_2 x_{t-2} + \dots + \alpha_q x_{t-q} + \varepsilon_t \tag{6}$$

where ε_t is a random "disturbance" term.

On the other hand, a conventional ECM for cointegrated series is of the form:

$$\Delta y_t = \beta_0 + \sum \beta_i \Delta y_{t-i} + \sum \gamma_j \Delta x_{t-j} + \sum \delta_k \Delta x_{t-k} + \phi z_{t-1} + e_t \tag{7}$$

Here, z, the "error-correction term", is the OLS residuals series from the long-run "cointegrating regression"

4. Results and Interpretations

4.1. Unit Root Test Result

Table-1. Unit Roots Test

Variables	ADF statistics	1% critical level	5% critical level	10% critical level	Order of Integration
GDP	-2.696647	-2.616203	-1.948140	-1.612320	I(1)
CO ₂	-7.569234	-2.615093	-1.947975	-1.612408	I(1)
URB	-4.091020	-3.577723	-2.925169	-2.600658	I(1)
IND	-5.069327	-2.624057	-1.949319	-1.611711	I(0)
ECM	-7.212587	-3.577723	-2.925169	-2.600658	I(0)

Source: Source: Author’s computation using Eviews 9 software

The unit root test results of the incorporated times series variables in the regression model are presented in Table 1. Using Schwarz Info Criterion, maximum lag length of 10 and no intercept or trend and intercept, the traditional test of the ADF here indicates that almost all the variables tend to be stationary in first difference except IND

variable that was stationary at level. However, URB variable was actually stationary at first difference when intercept was introduced. Hence, the series are integrated in of order 1(1) and I(0). This is evidence by the fact that the Absolute Values of the ADF test statistics are all greater than the critical values at the 1% and 5% level of significance. After stationarizing the variables, the data were then tested for co-integration.

4.2. The ARDL Bounds Testing Approach to Cointegration and ECM (OLS Approach) Result

Table 2 shows the first stage of the Auto Regressive Distributed Lag Models approach to co-integration. The model in equation 4 was estimated in static (level) form by using selection 1 as the maximum lags of dependent variable and independent variable. Constant (level) was deployed as the trend specification. The model selection method was Akaike info criterion (AIC). Based on the outcome on Table 2, a bound test was conducted and the test result is presented in Table 3. In Table 3, the F-statistic for the Bounds Test is 9.537207 this clearly exceeds 1% critical value for the upper bound. Accordingly, the hypothesis of "no long-run relationship" is rejected strongly. As such, the long run relationship was examined by employing the Error Correction Model (ECM) (OLS approach) to links the long-run equilibrium relationship among the time series implied by cointegration with the short-run dynamic adjustment mechanism. Estimates of the long run model is presented in Table 4 (where residuals were extracted and used to estimate the ECM in Table 5) while Table 5 shows short run dynamics with long run representative.

Table-2. ARDL

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LOG(CO2(-1))	0.564059	0.081399	6.929575	0.0000
LOG(GDP)	-0.440725	2.609175	-0.168914	0.8667
LOG(GDP ₂)	0.284666	1.290339	0.220614	0.8265
LOG(GDP ² (-1))	-0.080430	0.038129	-2.109439	0.0411
LOG(URB)	-0.459758	0.288672	-1.592663	0.1189
LOG(IND)	0.037258	0.049713	0.749467	0.4579
C	0.699656	1.388132	0.504027	0.6169
R-squared	0.910689	Mean dependent var		-0.348742
Adjusted R-squared	0.897619	S.D. dependent var		0.277101
S.E. of regression	0.088664	Akaike info criterion		-1.873880
Sum squared resid	0.322316	Schwarz criterion		-1.600997
Log likelihood	51.97312	Hannan-Quinn criter.		-1.770757
F-statistic	69.67806	Durbin-Watson stat		2.212612
Prob(F-statistic)	0.000000			

Source: Source: Author's computation using Eviews 9 software

*Note: p-values and any subsequent tests do not account for model selection

Table-3. ARDL Bound Test

Test Statistic	Value	k
F-statistic	9.537207	4
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	2.45	3.52
5%	2.86	4.01
2.5%	3.25	4.49
1%	3.74	5.06

Source: Source: Author's computation using Eviews 9 software

Table-4. Long Run Model Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.255152	1.412924	-0.180584	0.8576
LOGCO ₂ (-1)	0.577612	0.082379	7.011631	0.0000
LOGGDP(-1)	0.461652	2.571111	0.179553	0.8584
LOGGDP ² (-1)	-0.269612	1.279031	-0.210794	0.8341
LOGURB(-1)	-0.163947	0.303275	-0.540589	0.5916
LOGIND(-1)	0.051483	0.048186	1.068419	0.2914
R-squared	0.897986	Mean dependent var		-0.348742
Adjusted R-squared	0.885841	S.D. dependent var		0.277101
S.E. of regression	0.093625	Akaike info criterion		-1.782561
Sum squared resid	0.368160	Schwarz criterion		-1.548661
Log likelihood	48.78147	Hannan-Quinn criter.		-1.694170
F-statistic	73.94132	Durbin-Watson stat		2.133928
Prob(F-statistic)	0.000000			

Source: Author's computation using Eviews 9 software

The estimated coefficients of the long-run relationship in Table 4 shows that LOGCO₂(-1) is the only significant variable explaining environmental degradation (CO₂ emissions). LOGGDP(-1) and LOGGDP²(-1) indicated a certain improvement in environment as incomes increase. However, these relationships are statistically insignificant at any of the conventional levels.

Table-5. ECM (OLS approach): Short Run Estimates

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.033136	0.041111	0.806022	0.4250
D(LOGCO ₂ (-1))	0.645085	0.148513	4.343636	0.0001
D(LOGGDP(-1))	-1.312498	1.616270	-0.812053	0.4216
D(LOGGDP ² (-1))	0.586385	0.802610	0.730598	0.4693
D(LOGURB(-1))	-2.047184	1.782793	-1.148301	0.2577
D(LOGIND(-1))	0.173969	0.079836	2.179080	0.0353
ECMT2(-1)	-1.245926	0.219381	-5.679283	0.0000
R-squared	0.461965	Mean dependent var		-0.008947
Adjusted R-squared	0.381260	S.D. dependent var		0.113676
S.E. of regression	0.089418	Akaike info criterion		-1.854387
Sum squared resid	0.319823	Schwarz criterion		-1.578833
Log likelihood	50.57810	Hannan-Quinn criter.		-1.750694
F-statistic	5.724104	Durbin-Watson stat		1.875447
Prob(F-statistic)	0.000228			

Source: Source: Author’s computation using Eviews 9 software

From Table 5 (short run estimates), the linear term (LOGGDP) and the quadratic term (LOGGDP²) are not correctly signed. That is, coefficient on D(LOGGDP(-1)) is negative instead of positive while the coefficient of D(LOGGDP²(-1)) is positive instead of negative. These are measures that unveil retrogression with rising per capita income from previous years. However, these relationships are not statistically significant at any of the conventional levels. Invariably, the results do not support the EKC hypothesis, which assumes an inverted U-shaped relationship between income and environmental degradation. The short run results indicate that D(LOGCO₂(-1)) is the most significant variable in explaining environmental degradation (CO₂ emissions) in Nigeria followed by D(LOGIND(-1)).

CO₂, although not the most vigorous of the greenhouse gases, is the most **critical** on the strength of the enormous magnitude discharged into the air by fossil fuels combustion (e.g., gasoline, oil, coal) (Britannica, 2019). In 2016, CO₂ emission for Nigeria was 82,634.2 kt. Though Nigeria CO₂ emissions altered considerably in recent years, it tended to decrease through 1997 - 2016 period ending at 82,634.2 kt in 2016 (Knoema, 2018). The risk of climate change ascribable to emissions of CO₂ from fossil fuels is deemed to be the leading environmental threat from the existing energy system in the world. Nigeria comparable to other countries of the world has its own incident of climate change disasters like the one that struck 25 years ago in the north-eastern region currently comprising Borno and Yobe states, the southern part of Lake Chad, the section of it that lies inside Nigerian territory dried up (Beyioku, 2016).

Similarly, in developing countries like Nigeria where regulations are lax and level of ignorance high, industrialization brings about higher levels of pollution, unrestrained exploitation and inefficacy to build up connection between non-performances of social responsibilities to non-functionality of systems. The first time air pollution(CO₂ emission) snag emerged in Nigeria was in the 1960s during the nation’s first phase of industrialization and afterwards in the 70’s (Otti et al., 2011) and to date. Also, the Niger Delta region in Nigeria is left with series of stupendous environmental depredation from oil exploration and exploitation (Mgbemene et al., 2016).

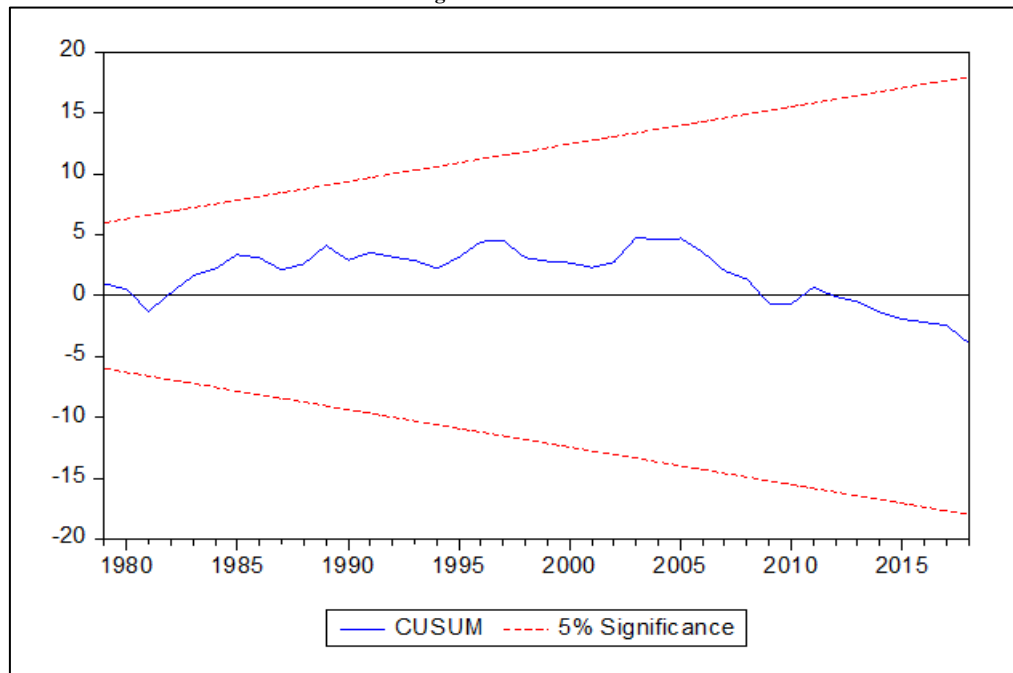
The equilibrium correction coefficient, estimated -1.245926 is significant (with a very low p value of 0.000.i.e. p< .001. This means highly significant), has the correct sign, and imply a high speed of adjustment to equilibrium after a shock. Approximately 124% of disequilibria from the previous year’s shock converge back to the long-run equilibrium in the current year. The serial correlation test in Table 5 shows the F-statistics as 0.2542. It is approximately 25% which is way above the 5% statistical significance level. As such, the null hypothesis of no serial correlation cannot be rejected. The CUSUM test in Figure 3 shows that the model is stable because it lies within the 5% boundary.

Table-6. Breusch-Godfrey Serial Correlation LM Test

F-statistic	1.420147	Prob. F(2,38)	0.2542
Obs*R-squared	3.268680	Prob. Chi-Square(2)	0.1951

Source: Source: Author’s computation using Eviews 9 software

Figure-3. CUSUM Test



Source: Author's computation using Eviews 9 software

5. Summary, Conclusion and Recommendations

Understanding the impact of economic development on the environmental quality is becoming increasingly important as general environmental concerns are making their way into main public policy agenda. The relationship between environmental quality and economic development has been empirically modeled through emissions-income relationship by many authors, and the outcome of most of these studies has been formulated by the so called Environmental Kuznets Curve hypothesis.

This paper examines the dynamic relationship among carbon dioxide (CO₂) emissions, economic growth, industrialization and urbanization based on the environmental Kuznets curve (EKC) hypothesis for the period 1970–2019 in Nigeria, using the ARDL Bounds testing approach to cointegration and ECM (OLS Approach). The estimated coefficients of the long-run relationship shows that LOGCO₂(-1) is the only statistically significant variable explaining environmental degradation (CO₂ emissions). LOGGDP(-1) and LOGGDP²(-1) indicated a certain improvement in environment as incomes increase. However, these relationships are statistically insignificant at any of the conventional levels.

In the short run, the linear term (LOGGDP) and the quadratic term (LOGGDP²) are not correctively signed. That is, coefficient on D(LOGGDP(-1)) is negative instead of positive while the coefficient of D(LOGGDP²(-1)) is positive instead of negative. These are indicators that display deterioration with rising per capita income from previous years. However, these relationships are not statistically significant at any of the conventional levels. Invariably, the results do not support the EKC hypothesis, which assumes an inverted U-shaped relationship between income and environmental degradation. The short run results indicate that D(LOGCO₂(-1)) is the most significant variable in explaining environmental degradation (CO₂ emissions) in Nigeria followed by D(LOGIND(-1)).

Reducing CO₂ emissions (environmental degradation) is a wise long term investment that contributes to several development goals. As such, policies and investments supporting cleaner transport and power generation, as well as energy-efficient housing and municipal waste management can reduce key sources of outdoor air pollution (CO₂ emissions) in urban areas of Nigeria and thus promote sustainable industrialization. Invariably,

- Automobile emission coming from both diesel engine and gasoline-engine must be controlled to help reduce urban carbon emissions(CO₂ emissions). In this case, the use of alternative energy sources in transportation sector such as natural gas-operated municipal buses should be encouraged in cities.

- Effort should be focused on industrial restructuring, industrial location, and adopting clean production technologies that reduce industrial emissions

References

- 123HELP ME (2018). The relationship between urbanization and industrialization essay. Available: <https://www.123helpme.com/relationship-between-urbanization-and-industrialization-preview.asp?id=191550>
- Adejoh, I. (2011). Environmental problems of industrialization and sustainable development in Nigeria-a review. Available: [https://oer.fukashere.edu.ng/uploads/oer/572-Environment%20and%20industrialization%20article%20\(1\).pdf](https://oer.fukashere.edu.ng/uploads/oer/572-Environment%20and%20industrialization%20article%20(1).pdf)
- Adeyemo, O. K. (2003). Consequences of pollution and degradation of Nigerian aquatic environment on fisheries resources. *Environmentalist*, 23(4): 297-306.

- Agbola, T. and Agbola, E. O. (1997). The Development of Urban and Regional Planning Legislation and their impact on the Morphology of Nigerian Cities. *Niger. J. Econ. Soc. Stud.*, 39(1): 123-44.
- Beyioku, J. (2016). Climate change in Nigeria: A brief review of causes, effects and solution. Available: <https://fmic.gov.ng/climate-change-nigeria-brief-review-causes-effects-solution/>
- Britannica (2019). Air pollution-Greenhouse gases. Available: <https://www.britannica.com/science/air-pollution/Greenhouse-gases>
- Cameron, S. (1994). A review of the econometric evidence on the effects of capital punishment. *Journal of Socio-Economics*, 23(1): 197-214.
- De Bruyn, S. M. (2000). *Economic growth and the environment: An empirical analysis*. Kluwer Academic Press: Dordrecht.
- Dover, D. (2018). USA. Worldometers.info. Available: <http://www.worldometers.info/world-population/nigeria-population/>
- Egunjobi, L. (1999). *Our gasping cities: An inaugural lecture*. University of Ibadan.
- Egunjobi, L., Onakomaiya, S. O. and Oyesiko, O. O. (2002). *Planning of the nigerian cities for better quality of life*. Environment, Physical Planning and Development: Nigeria. 89-107.
- Ehrlich, I. (1995). The deterrent effect of capital punishment: A question of life and death. *American Economic Review*, 65(1): 397-417.
- Gbaradi (2018). 10 most industrialized states in Nigeria. Available: <http://gbaradi.com/economy/10-industrialized-states-nigeria/>
- Grossman, G. M. and Krueger, A. B. (1991). Environmental Impacts of the North American Free Trade Agreement, NBER working paper 3914.
- Investopedia (2018). How does industrialization lead to urbanization? : Available: <https://www.investopedia.com/ask/answers/041515/how-does-industrialization-lead-urbanization.asp>
- Knoema (2018). Nigeria - CO2 Emissions. Available: <https://knoema.com/atlas/Nigeria/CO2-emissions>
- Kuznets, S. (1955). Economic Growth and Income Inequality. *Published on The American Economic Review*, 45(1): 1-28. Available: <http://www.jstor.org/stable/pdfplus/1811581.pdf?acceptTC=true&acceptTC=true&jpdConfirm=true>
- Lexicon Universal Encyclopedia (1997). 21 volume set by lexicon - goodreads. Available: <https://www.goodreads.com/.../25273107-lexicon-universal-encycl>
- Mgbemene, C. A., Chidozie, C. N. and Nwozor, C. (2016). Industrialization and its backlash: Focus on climate change and its consequences. *Journal of Environmental Science and Technology*, 9(4): 301-16.
- NREH (2017). A brief history of urbanization in Nigeria. Available: <https://nigeriarealestatehub.com/brief-history-urbanisation-nigeria.html/>
- Oluwole, A. F., Olaniyi, H. B., Akeredolu, F. A., Ogunsola, O. J. and bioh, I. B. (2005). *Impact of petroleum industry on air quality in Nigeria*. SEEMS (Nig.) Ltd: Lagos.
- Oni-Jimoh, T. and Liyanage, C. (2018). Urbanization and meeting the need for affordable housing in Nigeria. Available: <https://www.intechopen.com/books/housing/urbanization-and-meeting-the-need-for-affordable-housing-in-nigeria>
- Otti, V. I., Nwajuaku, A. I. and Ejikeme, R. I. (2011). The effects of environmental air pollution in Nigeria. *VSRD International Journal of Mechanical, Automobile and Production Engineering*, 1(1): 36-42.
- Owlcation (2018). Industrialization and economic development. Available: <https://owlcation.com/social-sciences/ROLE-OF-INDUSTRIALIZATION-IN-ECONOMIC-DEVELOPMENT-OF-THE-COUNTRY>
- Panayotou, T. (1997). Demystifying the environmental kuznets curve: Turning a black box into a policy tool. *Environment and Development Economics*, 2(1): 465-84.
- Peng, S. and Bao, Q. (2006). China's economic growth and environment pollution: An empirical study based on generalized response function. *China Industrial Economics*, 5(5): 15-23
- Photius, C. (2005). Nigeria urbanization since independence. Available: https://photius.com/countries/nigeria/society/nigeria_society_urbanization_since_i~10004.html
- Rothman, D. S. (1998). Environmental kuznets curve- real progress or passing the buck?: A case for consumption-base approaches. *Ecological Economics*, 25(1): 177-94.
- Selden, T. M. and Song, D. (1994). Environmental quality and development: Is there a kuznets curve for air pollution emissions? *Journal of Environmental Economics and Management*, 27(2): 147-62.
- Stern, D. I. (2004). The rise and fall of the environmental kuznets curve. *World Development*, 32(8): 1419-39.
- Suri, V. and Chapman, D. (1998). Economic growth, trade and the energy: Implications for the environmental kuznets curve. *Ecological Economics*, 25(1): 195-208.
- Svbic (2011). What is economic development? : Available: <http://www.svbic.com/node/24>
- Tyler, S. M. (2000). *Living in the environment: Principle connections and solutions*. Brooks/Cole: London.
- World Bank (1992). *World development report 1992*. Oxford University Press: New York.
- World Population Review (2019). Population of cities in Nigeria. Available: <http://worldpopulationreview.com/countries/nigeria-population/cities/>