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Environmental Degradation and Nigeria's Macroeconomic Space

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Abstract

The fear for the future of human existence on this planet has made it necessary to pay special attention to studies that are related to the environment. In view of this, this study attempts to re-examine the environmental Kuznets curve in the midst of selected macroeconomic variables in Nigeria. The study estimated the relationship between carbon dioxide emission and some selected macroeconomic variables such as energy consumption (proxied by energy price); gross domestic product; population density; trade openness; ratio of manufacturing as a share of GDP and foreign direct investment using the ARDL model. With the adoption of secondary data for the period of 1981 to 2016 obtained from the world development indicator, the findings validated an N-shaped relationship between economic growth and the pollution in Nigeria in the midst of other Macroeconomic variables and based on this, it was recommended among others the building of a strong and effective environmental regulatory framework for the Nigerian economy and the adoption of clean technologies for the Nigerian economy

Keywords: Co2, GDP, EKC, Energy Price, FDI, ARDL, Population

1. Introduction

The future of humanity on the planet is highly endangered due to studies that revealed the unprecedented harm on the ecosystem which is a consequent of the huge accumulation of co2 on the ecosystem that resulted deeply in the depletion of the ozone layer causing catastrophic climatic changes. The Intergovernmental Panel on Climate Change IPCC (2007) reports that the most important environmental problem of our age is global warming. The alarming uprising in the volume of global Co2 emissions seems to be worsening the situation. The co2 emissions majorly results from fossil fuel consumption, so curbing the consumption of energy could have helped in mitigating the effect of these global warming, but, owing to the adverse effect of reduction of energy consumption on the growth of the economy, it becomes complicating. (Soytas & Sari, 2007). Therefore, nations of the whole world are pushing for green energy with less harmful effect on the environmental, but if the environmental Kuznets hypothesis is applicable to the Co2 and growth linkage, the growth by its own may end up being a solution to the problem of degradation (Rothman & De Bruyn 1998)

Environmental pollution or degradation is a major issue confronting developing countries including Nigeria today. The proposed economic recovery of Nigeria which is just coming out from a recession is not without a price. For instance in Nigeria, the main source of foreign exchange as well as revenue comes from crude oil, so gas is burnt on a daily basis, thereby disrupting the atmosphere. Oil spillage has hindered locals of such areas from carrying out economic activities on their farms. Water from the streams are no longer fit for human consumption, while the country's increasing population has created more pressure on the environment and sources of likelihood. More so, livelihood sources are such that hampers environmental quality, as a large percentage of the population depends largely on traditional biomass for heating and cooking purposes. Also increase in the population of a society increases the pressure on the available resources like land, and other natural resources for the survival of humanity (Ityavyar &Thomas, 2012).

While studies have been investigating the existence of the inverted U-shaped curve in Nigeria, few have discussed population density as one of the explanatory variables. The relevance of checking if EKC exits emanated from the fact that, it is far from just an academic exercise. If the Environmental Kuznets curve is found for an economy, this will be an indication that holding other factors constant, that the harmful effect of growth on the environment will on its own decrease depending on time period as the economy grows. Also, if the environmental Kuznet curve proposition is not found for an economy, it is an indication that government policy would be essential in reducing the harmful effect and ensure a human friendly development for the economy. The implication of all these is that it would provide the bases for an interdisciplinary approach to the design of environmental policy of nations and regions of the world. Other variables researchers have not really paid much attention to is the role of global integration in this relationship. Thus, review of the role of the level of openness of the economy to the outside world, the impact of FDI inflows and the likes have been given less attention. Perhaps, this could explain the inability of most studies to find the presence of the inverted U-shaped curve in the case of Nigeria. Thus, the results obtained by past studies could have been plagued by the problem of core variable omission bias. These observations have made it imperative to ask the following research questions: on the basis of the selected macroeconomic variables, does the EKC hypothesis hold for Nigeria?

This study is divided into sections: the next section is the literature review, while section three discusses the methodology of the study. Subsequently the fourth section presents the results, while section five is the conclusion of the work.

2. Literature Review

2.1 The Environmental Kuznets Curve (EKC) Hypothesis

The EKC had its origin from the time-series pattern of income inequality described by Kuznets in 1995 which later according to Richmond & Zencey, (2007) metamorphosed into an important concept in environmental economics. The proponents of the EKC believed there is a linkage between environmental degradation and income per capita of all the economies of the world. It propounds that as an economy grows, environmental degradation would increase, however, as a particular level of income per capita is attained, there would be a reverse of the prevailing pattern such that at a high level of income, growth would result in a friendlier environment (Stern, 2003). The Kuznets curve which was basically a tool for measuring inequality among nations took a turn and became a measurement tool for the relationship between economic growth and carbon emission which is the major cause of environmental degradation (Grossman & Krueger, 1991).

Prior to the Environmental Kuznets curve postulation by Grossman and Krueger (1991) it was a general believe that the developed economies have contributed greatly to global pollution much more than developing economies, owing to the fact that the level of economic activities in the industrialized economies which are pollution-intensive are high.

The ECK hypothesis disproves the widely held argument that the rise in growth leads to increased pollution since more income results to increase in consumption, hence, more pollution. However, the EKC hypothesis recognizes the probability that there may be the opposite effect of increasing pollution with increase in income, rather than decrease in pollution. But the combination of the both effects can still lead to environmental degradation first increasing and then decrease with increases in growth (Carson & McCubbin, 1997).

The series of reasons that will make environmental degradation to fall with growth can likely be grouped into two main groups. Firstly is that high income economies tend to use divergent technologies in the production of goods and services that are less polluting in nature or the fact that high income economies will likely use the later vintage technologies, which are more efficient in comparison with other economies, especially with respect to consumption of energy. The second group is that human beings will naturally need and sought for better quality of the environmental quality they become richer (Carson & McCubbin 1997).

The environmental Kuznets curve concept was made popular by the World Bank's world development report (WDI, 1992) where it posits that the idea that the higher the economic activities, the higher the environmental degradation is formed on the static assumptions about technology, environmental investments and taste. As an economy grows, the need and demand for improved environmental quality will equally grow, together with the resources available for investment. In backing this argument, Beckerman (1992) opined that there is confirm prove that, although the growth of an economy usually leads to increase in pollution in the economy at the early stages of the growth, at the end, the best and possibly the only way to achieve a nice environment in most nations is just to become rich.

2.2 Empirical Literature

Busayo (2016) studied the relationship between fossil fuel consumption, the environment and economic growth in Nigeria by using data from 1970-2013. Applying the VECM technique, Busayo (2016) found that fossil fuel consumption and CO_2 emissions impact significantly on economic growth. Also the study found the existence of an N-shaped relationship between environmental pollution and economic growth thereby disputing the presence of the EKC hypothesis for Nigeria. It therefore recommended that government should formulate economic growth policies in tandem with emission regulations to combat environmental degradation.

Nnaji, Chukwu, and Nnaji (2013) looked at Supply of electricity in Nigeria, Nigeria's Consumption of fossil fuel, Co2 Emissions in Nigeria and Growth in Nigeria using an Autoregressive Regressive Distributive Framework with data from the CBN statistical bulletin ranging from 1971 to 2009 and found that economic growth is associated with increases in environmental degradation while there is positive significant relationship between the supply of electricity and environmental degradation in Nigeria.

Wolde (2015) studied the relationship between economic growth and environmental degradation in Ethiopia by questioning the existence of environmental Kuznets Curve. Wolde (2015) applied a time series data from Ethiopia ranging from the period of 1969 to 2010 in a Vector error correction model. His finding indicates the existence of the EKC hypothesis in Ethiopia and therefore argued that to sustain the current trend in pollution abatement, the country have to sustain the existing environmental friendly economic policy.

In a similar study, Oshin and Ogundipe (2015) estimated the existing linkage between economic growth and environmental pollution in West Africa to ensure if the Environmental Kuznet Curve hypothesis exists in the West African sub region which was ranked one of the poorest regions of the world. The study adopted a static panel data regression methodology for all the nations that make up the membership of the Economic Community of West African States (1980-2012). Employing GDP per capita, literacy rate, population density, trade openness and a measure of institutional quality, the available result from their estimation procedure re-established the existence of the EKC hypothesis in the studied economies. Again, Ogundipe, Olurinola and Odebiyi (2015) investigated the link that exists between per capita income and environmental pollution in the West Africa sub region in a panel study framework with data for the period of 1990 to 2012. Their specific objective was to estimate EKC for four indicators of environmental quality such as CO2emissions, Suspended particulate matter, lack of access to sanitation infrastructure and lack of adequate drinking that is safe and confirm if the pollutants indicates an inverted u-shape relationship. Using the CO_2emissions variable, the study could not find an unambiguous evidence of an inverted u-shaped relationship. That notwithstanding, the rest results was confirmations of the existence of the environmental Kuznets curve hypothesis in the study area. They subjected their estimations to further robustness checks by ascertaining the statistical properties of the variables used and examined their long run sustainability; results were found to be consistent and suitable for policy inferences. They therefore recommended that government institutions and civil society need to propagate more awareness campaigns for environmental management. Similarly, they also suggested the need to build strong and effective environmental regulatory framework, increase abatement measures and adopt clean technologies in manufacturing of commodities and also services.

Balin and Akan (2015) contributes to the ongoing debate in the literature by comparing two different EKC specifications for 27 developed countries in a panel data study (1997-2009). Their N shaped relationship findings revealed that research and development expenditures are negatively associated with CO_2 emissions while patent applications and industrial productions are positively associated to CO_2 emissions. The study recommended that more eco-friendly industrial process should be encouraged.

Ojewumi (2015) investigated the validity of Environmental Kuznets Curve (EKC) hypothesis in Sub-Saharan African countries, using panel data analysis for the period 1980 - 2012. The study estimated the impact of growth on environmental degradation of the sub-saharan African economies in a panel data study using data obtained from WDI. The results of the empirical analysis supports the validity of the EKC hypothesis for solid emission (CSF) and composite factor of emission (CFE). The findings also show that SSA countries need to harmonize a well-coordinated environmental and economic policy mix that would ensure greater output but at the same time protect their environment from degradation and pollution. This study is likened to that of Çetin & Ecevit (2015) on Urbanization, Energy Consumption and CO2 Emissions in Sub-Saharan Countries where they applied a panel cointegration and causality analysis to find that that energy consumption and urbanization have proved to be the main determinants of environmental pollution in about 43 economies that was studied.

3. Methodology

The framework for this study follows that of Kuznets (1955) who propounded the notion of an inverted U-shape linkage between income inequality and the growth of economies. According to Kuznets (1955), when an economy develops at a low level, the growth of such economy results to an increase in inequality, the inequality increases until a turning point where further development of the economy decreases inequality in the economy.

The concept of economies of scale posits that as a country grows, all the economic activities in the economy will increase in equal proportion to the amount of the economic growth, (that is, environmental degradation will equally increase in equal proportion to the level of growth) especially at the early stage of growth, as the economy grows, the mix of output for the economy changes, leading to a shift especially away from agriculture towards mostly heavy industrial production which will increase the level of emission in the economy. However, according to Stern (2003) in later stages of growth or development, the economy shifts to lower resource intensive services and fewer manufacturing that will likely result to decreased level of environmental emissions resulting in less environmental damages.

This study adopted the EKC hypothesis model because it is one of the few models that actually reveal how a technically specified measurement of environmental quality may vary or reverse as the fortunes of an economy change. Thus, in analyzing the relationship, a reduced-form equation is typically used, where the level of environmental degradation or pollution is regressed upon per capita income, the squared value of per capita income and additional determinants. This is done instead of modelling structural equations where environmental regulations, technology and industrial composition are related to GDP, and pollution is related to the regulations, technology and industrial composition.

Following reduced form equation proposed by Grossman and Krueger (1995), which is an extension of the model developed by Kuznets (1955) to examine the relationship between income-inequality and economic development, is typically used to test the EKC hypothesis:

$$y_{it} = a_i + \tau_i \quad + \beta_1 x_{it} + \beta_2 x^2{}_{it} + \beta_3\, x_{it}^3 \ + z'\gamma + \epsilon_{it} \tag{3.1}$$

where the *i* and *t* subscripts denote the country and time, *y* is a certain environmental degradation indicator, α is a country-specific effect,

τ = time-specific effect

x = per capita income

Z = vector of other explanatory variables which according to economic theory can influence the quality of the environmental. Often logarithmic values of environmental indicators and income are used in the estimations. This is done in order to smooth the distribution of the data, and because the predicted *y*-variable only can take on positive values (some environmental damage is always expected to occur).The logarithmic specification of the EKC model usually take the form:

$$logy_{it} = a_i + \tau_i \quad + log\beta_1 x_{it} + log\beta_2 x^2{}_{it} + log\beta_3\, x_{it}^3 + logz'\gamma + \epsilon_{it} \tag{3.2}$$

Thus, the EKC hypothesis is confirmed if $\beta_1>0$, $\beta_2<0$ and $\beta_3=0$, where $\beta_1>0$ captures the linear increase of environmental degradation with income, and $\beta_2<0$ indicates the existence of the function's maximum, or "turning point". If $\beta_1>0$, $\beta_2<0$ and $\beta_3>0$, the relationship between the variables is cubic or N-shaped.

The turning point Φ of the EKC function is obtained at the coefficient on y over twice the absolute value of the coefficient on y^2, i.e.:

3.1 Model Specification

The following model is specified for the study

$$CO_2 = f(gdp, (gdp)^2, (gdp)^3, z) \tag{3.3}$$

While econometrically, the equation is specified as

$$CO_{2t} \quad = \alpha_0 \ + \ \delta_1 gdp_t + \ \delta_2 (gdp_t)^2 + \delta_3 (gdp_t)^3 + \delta z_t + \mu_t \tag{3.4}$$

where CO_2 equals carbon dioxide emissions per capita (proxy for environmental degradation); *gdp* is per capita real income; *z* is a vector of other variables that may also affect environmental quality; *t* is time; α is the constant term while δ are the coefficients of the explanatory and control variables and μ is error term which is not correlated with the Carbon emission the dependent variable and it is also independently and identically distributed with mean of zero.

Some researchers estimate equation (3.4) without the cubic term $\delta_3(gdp_t)^3$. This technique, however, is too favourable to the EKC hypothesis. The cubic formulation, by contrast, allows for both inverted *U*-shaped EKC and monotonically rising environment - income relationship. Additionally, it has the advantage that the EKC does not have to be symmetric as in the quadratic formulation: the cubic function may rise faster than it declines or vice-versa. Secondly, for various reasons such as data availability and or small sample size, most studies usually omit the variable *z* in their estimation (e.g. Akbostanci, E., Turut-Asik, S., & Tunc, G. I. (2009); Fodha & Zaghdouf, 2010) as cited in Akpan & Chuku (2011), preferring instead to regress *gdp* per capita against a measure of environmental quality. This may have led to core variables omission bias as many other factors have also been found to significantly affect environmental degradation. Secondly, establishing an EKC in the presence of other moderate factors provides a more convincing basis for validation of the hypothesis (Omotor, 2015). Thus, following the method adopted by Akpan & Chuku (2011); Ahmed & Long (2012); Shahbaz *et al* (2015) the vector *z* in equation (3.4) is expanded to have:

$$CO_{2t} = \ \alpha_0 \ + \ \delta_1 gdp_t + \ \delta_2 (gdp_t)^2 + \delta_3 (gdp_t)^3 + \delta_4 ec_t + \delta_5 pop_t + \delta_6 tr_t + \delta_7 man_t + \delta_8 fdi_t + \mu_t \tag{3.5}$$

where *ec* is energy consumption (proxied by energy price); *pop* is population density; *tr* represents trade openness; *man* is the ratio of manufacturing output to GDP while FDI = foreign direct investment.

It is to be noted that according to Cameron (1994) and Ehrlich (1996) log-linear specifications yields more appropriate and more efficient results as compared to a simple linear model. Again, log form of variables yields direct elasticities that make it easier for interpretations. Hence, equation (3.5) is specified thus:

$$\begin{aligned} lnCO_{2t} = \ & \alpha_0 \ + \ \delta_1 lngdp_t + \ \delta_2 (lngdp_t)^2 + \delta_3 (lngdp_t)^3 + \delta_4 lnec_t + \delta_5 lnpop_t + \delta_6 lntr_t + \delta_7 lnman_t \\ & + \delta_8 lnfdi_t + \mu_t \end{aligned} \tag{3.6}$$

where all variables are as earlier defined and *ln* is the natural log of the variables.

Getting the ARDL form of the equation, we have

$$\Delta lnCO_{2t} = \propto_0 + \sum_{k=1}^{n} \propto_k \Delta lnCO_{2t-k} + \sum_{k=1}^{n} \propto_k \Delta lngdp_{t-k} + \sum_{k=1}^{n} \propto_k \Delta(lngdp_{t-k})^2$$
$$+ \sum_{k=1}^{n} \propto_k \Delta(lngdp_{t-k})^3 + \sum_{k=1}^{n} \propto_k \Delta lnec_{t-k} + \sum_{k=1}^{n} \propto_k \Delta lnpop_{t-k} + \sum_{k=1}^{n} \propto_k \Delta lntr_{t-k}$$
$$+ \sum_{k=1}^{n} \propto_k \Delta lnman_{t-k} + \sum_{k=1}^{n} \propto_k \Delta lnfdi_{t-k} + \lambda_1 lnCO_{2t-k} + \lambda_2 lngdp_{t-1} + \lambda_3 (lngdp_{t-1})^2$$
$$+ \lambda_4 (lngdp_{t-1})^3 + \lambda_5 lnec_{t-1} + \lambda_6 lnpop_{t-1} + \lambda_7 lntr_{t-1} + \lambda_8 lnman_{t-1} + \lambda_9 lnfdi_{t-1} + + U_t \quad (3.7)$$

here $\propto_0$ is the drift parameter and Δ is the first difference operator. λ_i represents the long-run multipliers while the terms with summation signs are used to model the short-run dynamics structure. The Akaike Information and Schwartz-Bayesian Criterion (SBC) will be the bases for the selection of the appropriate lag length while *F*-test or Wald Statistics is the test procedure

From the foregoing, the following relationships are expected to hold between income and the environment with varying signs of δ_i:

when $\delta_1 > 0, \delta_2 < 0$ *and* $\delta_3 > 0,$ the results simply shows there is an *N*-shaped interrelationship between growth of and economy and pollution.

when $\delta_1 < 0, \delta_2 > 0$ *and* $\delta_3 < 0,$ the result shows an inverse of the *N*-shaped relationship between the growth of an economy and pollution

when $\delta_1 > 0, \delta_2 = 0$ *and* $\delta_3 = 0,$ this indicates a monotonically increasing relationship between the growth of an economy and pollution

when $\delta_1 > 0, \delta_2 > 0$ *and* $\delta_3 = 0,$ this result shows a *U*-shaped relationship between growth of an economy and pollution

Finally, when $\delta_1 > 0, \delta_2 < 0$ *and* $\delta_3 = 0$, this result reveals an inverted *U*-shaped relationship between the growth of an economy and pollution in other words, suggesting that the EKC hypothesis exists for the economy.

4. Result

4.1 Test for Unit Root Result

Table 1. Summary of Philip Peron test result of the series

Variables	Test Critical Values (5% Level)	Philip Peron test stat	Order of integration
LNCO2	-3.444756	-5.375623	I(1)
LNGDP	-3.443704	-4.839232	I(1)
$LNGDP^2$	-3.443704	-4.983827	I(1)
$LNGDP^3$	-3.443704	-4.991164	I(1)
LNMAN	-3.443704	-6.112072	I(1)
LNPOP	-3.443704	-4.326128	I(1)
LNEC	-3.443704	-11.31597	I(1)
LNTR	-3.443704	-11.95732	1(1)
LNFDI	-3.443704	-6.721769	I(1)

Source: Authors computation with Eviews 9

The result proved that none of the variables is I(2) and that the variables are either I(0) or I(1) which is one of the major conditions to use ARDL estimation technique as those variables that were not stationary were differenced to get rid of the stochastic trend, a phenomenon associated with time series data.

4.2 ARDL Bound Test

Criterion (HQC). The critical values reported in Pesaran et al. (2001) are equally adopted. Table 2 reports the result of the ARDL approach to co-integration.

Table 2. The ARDL bound test

Null Hypothesis: No long-run relationships exist		
Test Statistic	Value	k
F-statistic	3.400123	8
Critical Value Bounds		
Significance	I0 Bound	I1 Bound
10%	1.95	3.06
5%	2.22	3.39
2.5%	2.48	3.7
1%	2.79	4.1

From the result on table 2 above, it can be viewed that the bound test F-statistics of 3.400123 is greater than the upper bound critical value 3.39 at 5% level of significance. This indicates that there is a long run relationship among the variables. And this result qualifies us to move on with the estimation of the ARDL model.

4.3 Estimation Results

Table 3. Estimated Long-run Coefficients Based on ARDL **(**3, 1, 0, 3, 0, 1, 1, 1, 0**)**

Regressor	Coefficient	Standard Error	t-Statistics	p-Value
Dependent Variable: LNCO2				
LNGDP	0.000179**	0.000062*	2.882948	0.0047
$LNGDP^2$	-42.460547**	7.881496*	-5.387372	0.0009
$LNGDP^3$	29.566345**	5.240992*	5.641364	0.0001
LNMAN	0.773733**	0.330765*	2.339227	0.0211
LNPOP	0.607336	2.051135*	0.296098	0.7677
LNEC	0.722517**	0.234748*	3.077845	0.0026
LNTR	1.462942	1.890186*	0.773967	0.4406
LNFDI	-0.000007	0.000009*	-0.791200	0.4305
C	-50.106537**	19.764125*	-2.535227	0.0126
Notes: R^2 =0.610827 Adjusted R^2 = 0.547144 S.E of regression = 0.046623 F-statistics = 9.591703 Prob(F-statistics) = 0.0000 Durbin Watson = 1.941127				

(**) Denote significant at 5% level (*) denotes Heteroscedasticity and Autocorrelation (HAC) consistent standard errors. *Source: Authors computation using Eviews 9.0*

Based on table 3, the long-run elasticity on co2 emission with respect to GDP^2 in Nigeria is negative as expected. The long-run impact of GDP on co2 emission is positive and indicates that a one unit increase in GDP increases co2 emission by about 0.02 percent, holding all other factors constant. This result is statistically significant but the result indicates a negative relationship between co2 emission and GDP^2. That is, a percentage increase in the square of GDP holding all other factors constant decrease co2 emission by about 42 percent. Despite the above positive results of the square of GDP, the result indicates that GDP cube has a positive impact to co2 emission in the model. The result also shows that a one percent increase in the share of manufacturing to GDP, increase carbon emission by about 77 percent holding all other factors constant, such magnitude points to the huge impact manufacturing activities have on the carbon emission in Nigeria, this result is also found to be statistically significant. The other macroeconomic variables such as population density is also found to positively impact on co2 emission as a percentage increase in population density in Nigeria increase co2 emission by about 61 percent, while a percentage increase in energy price increase co2 emission by about 72 percent holding other factors constant. However, the result found a negative impact of foreign direct investment on co2 emission in Nigeria as a unit increase in FDI reduces co2 emission by 0.0007 percent while a unit increase in the level of openness of an economy increases co2 emission by over 100 percent, showing the magnitude of the impact trade openness have on the Nigerian environment.

From expectations, when GDP is positive, GDP^2 is negative and GDP^3 is positive, this indicates an N-shaped relationship between income and the environment, while, when GDP is negative, GDP^2 is positive and GDP^3 is negative, the result indicates an inverse of the N-shaped relationship between income and the environment. Also when GDP is positive, GDP^2 is equal to zero and GDP^3 is equal to zero, the model connotes a monotonically increasing relationship between income and the environment and a U shape relationship between income and the environment, while when GDP is positive, GDP^2 is negative and GDP^3 is equal to zero, it connotes an inverted U-shaped relationship between income and the environment and thus suggesting the EKC hypothesis.

The objective here is to find out if EKC hypothesis hold for Nigeria on the bases of a modified macroeconomic framework. The result of the study as indicated on table 4.5 above shows a positive GDP coefficient, negative GDP^2 coefficient and a positive GDP^3 coefficient there by confirming the existence of an N-shaped relationship between income and the environment, refuting the idea of an inverted U shaped relationship between income and the environment, thus, suggesting the non-existence of the EKC hypothesis for Nigeria. This finding serves as a confirmation to that of Busayo (2016) who notwithstanding the methodological shortfalls of the model found an N- shaped relationship between income and environment degradation, however, the study is not in agreement with several other studies such as Aduebe (2013), Nnaji, et al., (2013), Oyedepo, (2014), etc whose results attest the existence of EKC in Nigeria, however, these result as argued earlier are marred with one methodological issue or the other.

The next step is to analyse the short run dynamic impact of selected macroeconomic variables and environmental degradation in Nigeria which is obtained through the error correction model and presented on table 4 below.

Table 4. Short run Dynamics and Diagnosis

Dependent Variable: LNAGOP				
Regressor	Coefficient	Standard Error	t-Statistics	p-Value
D(LNCO2(-1))	0.435816	0.083118	5.243319	0.0000
D(LNCO2(-2))	0.194479	0.085524	2.273965	0.0249
D(GDP)	0.000094	0.000050	1.895798	0.0606
D(LNGDP2)	-3.928441	6.028320	-0.651664	0.5160
D(LNGDP3)	3.104212	3.957141	0.784458	0.4345
D(LNGDP3(-1))	-0.315770	0.384663	-0.820899	0.4135
D(LNGDP3(-2))	-0.302111	0.214333	-1.409538	0.1615
D(LNMAN)	0.071586	0.028453	2.515952	0.0133
D(LNPOP)	132.471258	71.089697	1.863438	0.0651
D(LNEC)	0.021365	0.025967	0.822767	0.4124
D(TR)	-1.046990	0.281038	-3.725445	0.0003
D(FDI)	-0.000001	0.000001	-0.812944	0.4180
CointEq(-1)	-0.092520	0.020935	-4.419420	0.0000
Diagnostic Tests				
Test	F-statistics	Prob. Value		
χ^2 SERIAL	0.305423	0.7374		
χ^2Heteroskedasticity Test: Breusch-Pagan-Godfrey	1.722312	0.0488		
χ^2 REMSAY	9.400865	0.1866		

Source: Authors computation using Eviews 9.0

Table 4 above reports the result of short dynamics of the selected macroeconomic variables and co2 emission in Nigeria. The negative statistically significant estimate of CointEq(-1) validates the established long run relationship among co2 emission, GDP, log of GDP^2, log of GDP^3, log of manufacturing share of GDP, log of population density, log of energy price, trade openness and foreign direct investment in Nigeria. The results also indicate that the estimate of CointEq(-1) is -0.092520 and is statistically significant at 5 percent level. This implies that about 9.2 percent of the deviations from long run equilibrium are corrected for in the next quarter period, that is , that is, it may take about 11 quarter (almost a year) to arrive the long run period.

4. Conclusion

This study re-examined the Environmental Kuznets curve hypothesis in the midst of selected macroeconomic variables in Nigeria. Different macroeconomic variables such as energy consumption (proxied by energy price); population density; trade openness; ratio of manufacturing as a share of gross domestic product and FDI were included in the study together with GDP per capita. The study validated an N-shaped relationship between income and the environment in Nigeria in midst of other Macroeconomic variables. Though a negative relationship exist between foreign direct investment and co2 emission in Nigeria which is not as expected, the study however, shows a positive link between price of energy and environmental degradation in Nigeria. Also, this study does not find a support for an inverted U shaped relationship between growth and pollution for the Nigerian economy which is consistent with empirical evidences from the works of Busayo (2016) and contrary to that of Aduebe (2013), Nnaji, et al., (2013), suggesting that the cost for environmental degradation for Nigeria is relatively high, though Nigeria has not yet reached the level beyond which pollution-income relationship for such pollutant becomes negative. Therefore, there is need to build strong and effective environmental regulatory framework for the Nigerian economy, improve on the carbon dioxide measurement for Nigeria and the adoption of clean and environmental friendly technologies for the economy of Nigeria in Nigeria's quest to be an industrial hub in Africa.

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