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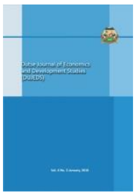

AN ANALYSIS OF THE RELATIONSHIP BETWEEN ECONOMIC GROWTH AND CO_2 EMISSIONS IN NIGERIA

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Abstract
This study examines the influence of economic growth, financial development, energy consumption, and FDI on carbon dioxide emissions in Nigeria from 1981-2014 by employing the ARDL bound testing method. The results of the bound test indicated the existence of long-run association among the variables under consideration. The short-run estimates show that all the variables are positively related to carbon dioxide emissions. While the long-run analysis indicates that economic growth, financial development, energy consumption is significant and positive in determining carbon dioxide emissions. However, FDI is not significant in explaining carbon dioxide emissions in Nigeria. The study recommends that policymakers in Nigeria should encourage the use of energy efficient technologies and other forms of energy like solar, wind, and biofuels to lessen the damaging effect of carbon dioxide emissions.

Keywords: CO_2 emissions, Economic Growth, Financial Development, Energy Consumption, FDI, ARLD.
JEL Classifications: Q52, Q54

Introduction

The increasing amount of global carbon dioxide emissions (CO_2) seems to be intensifying environmental problem through greenhouse effect that resulted in global warming (IPCC, 2007). The threat of global warming and climate change has focused attention on the relationship between economic growth and environmental pollutants. In 2007, the intergovernmental panel on climate change reported that the average global temperature was estimated to rise between 1.1 to 6.4° C by 2035. It is predicted that a mere 2° C increase in temperature would generate a substantial change to many natural ecosystems and rise in the sea-level that would have a major problem on the lives of half of the world's population that live in coastal zones (Lean & Smyth, 2010). In recent years, most of the developing countries have increased their carbon dioxide emissions to pursue higher economic growth, and this has become the greatest concern of the international community, especially with regards to the environmental quality. Therefore, many developing countries are encouraged to reduce their Carbon dioxide emissions in the near future (Kojima & Bacon, 2009). It has been argued that several factors influence the growth of carbon dioxide emissions, such as economic growth, energy consumption, urbanization, and population density.

In Nigeria, carbon dioxide emissions have been on an increasing trend, which if not control will add to the global concentration of greenhouse gases. For instance, in 2000, 79,170.53 kilotons of carbon dioxide emissions were recorded. Similarly, in 2013, carbon dioxide emission increased to 95,650.03 kilotons (WDI, 2017). In this regard, the increasing trend of carbon dioxide emission in Nigeria may be connected to the improvement of economic growth and development, as the gross domestic product increases from $46.39 billion in 2000 to $514.97 billion in 2013(WDI, 2017). Moreover, it important for Nigerian policymakers to reduce the concentration of CO_2 emission to safeguard the environment and quality life of people. Various studies have analyzed the extent to which economic growth influenced carbon dioxide emissions in industrialized and emerging countries. However, very few studies linked economic growth and carbon dioxide emission in Nigeria.

Hence, the objective of the present study is to examine the effect of economic growth on carbon dioxide emission in Nigeria. In achieving this objective, the study is divided into five parts. This is an introduction, followed by literature review as the second part. The third part is methodology and the fourth part is result and analysis, while the last part is conclusion and policy implication.

Literature Review

Relationship between economic growth and CO_2 emissions has been analyzed extensively in recent literature. For instance, a study by Shahbaz *et al*., (2013) investigate the effect of GDP, energy consumption, financial development, trade openness CO_2 emissions in Indonesia by applying the ARDL technique for the period 1975 to 2011. The study reveals a positive association between GDP, energy consumption, and CO_2 emissions. Similarly, Tiwari, Shahbaz, and Hye (2013) concluded that economic growth induces more CO_2 emissions in India. Meanwhile, Saboori, Sapri, and bin Baba (2014) examine the link between GDP and CO_2 emissions in 27 OCDE countries by utilizing Fully modified ordinary least square (FMOLS) technique for the period 1960 to 2008. The finding reveals that GDP increases the level of CO_2 emissions.

Shahbaz *et al*. (2014) maintained that economic growth improves the level of carbon dioxide emissions in the UAE. Shahbaz, Mutascu, *et al*. (2014) examine the association between economic growth, energy use, and CO_2 emissions in Romania. The study found that economic growth and energy use enhances carbon dioxide emissions. Their finding also supports the existence of the Environmental Kuznets Curve (EKC) hypothesis. Similarly, Asici (2015) confirmed the existence of a positive association between GDP and CO_2 emissions in emerging economies. Javid and Sharif (2016) investigate the influence of financial development, real income, trade openness, and consumption of energy on CO_2 emissions in Pakistan. The study shows that financial development, income, and consumption of energy promotes CO_2 emissions. Saimanul and Abdul-Rahim (2017)have concluded that economic growth induces more CO_2 emissions in Malaysia.

Likewise, Cetin and Ecevit (2017) reveal that financial development increased CO_2 emissions in Turkey. However, a study by Dogan and Seker (2016) found a negative relationship between economic growth and carbon emissions in OECD countries. Heidari, Katirciog, and Saeidpour (2015) examine the influence of energy use on CO_2 emissions in 5 Asian countries from 1980 to 2008. The study reveals that energy use rises CO_2 emissions. Al-mulali and Ozturk (2015) concluded that energy consumption increased CO_2 emissions in MENA countries. Moreover, study by Koçak and Şarkgüneşi (2018) examine the influence of FDI on carbon dioxide emissions in Turkey over the period 1974 to 2010. The finding shows that FDI promotes the level of CO_2 emissions. Jiang (2015) argued that FDI increases CO_2 emissions in the Chinese region. In addition, Chen, Wang, and Zhong (2019) studied the role of economic growth, energy consumption, and trade on CO2 emissions in China. The study found economic growth accelerates carbon dioxide emissions. Wang and Li (2019) used nonlinear modeling to analyze the impact of economic growth on CO2 emission in China. The outcomes of the study indicate a positive relationship between economic growth and CO2 emissions.

Many studies have analyzed the relationship between economic growth, financial development, energy consumption, FDI, and CO_2 emission in developed countries. However, very few studies linked economic progress to CO_2 emission in less developed countries like Nigeria. Additionally, based on the literature reviewed, there is a lack of studies on environmental quality measures in the studied area. Hence, examines the influence of economic growth on CO_2 emission in Nigeria will contribute to the existing literature, particularly on economic growth – carbon emissions nexus and environmental studies in Nigeria.

Methodology

Time series data are used in this study over the period 1981 –2014. World development indicator is the source of data used in this study. The variables considered are carbon dioxide emissions in kiloton, GDP per capita (current USD) financial development (private sector credit/ GDP), energy consumption (kg of oil equivalent) and FDI inflows (percentage of GDP). The data are transformed to their natural log values for easy interpretation in elasticity form. The descriptive statistics are shown in Table 1. The table shows the minimum, maximum, mean values and standard deviation of the dependent and four independent variables. The descriptive statistics show that the values of mean and standard deviation for energy consumption are the highest compared to other variables.

Table 1; Descriptive Statistics

Variables	Min	Max	Mean	SD
LCO2	10.46	11.5	11.0	0.37
LGDP	2.18	3.50	2.73	0.37
LFD	2.16	3.64	2.65	0.32
LEC	15.8	22.8	19.6	1.65
LFDI	0.02	2.38	0.95	0.60

Source: Author's Compilation using E-views

Model Specification

Unit Root

This study uses Augmented Dickey-Fuller (ADF), and Phillip Perron (PP) tests to find the order of integration and stationarity properties of the variables. ADF test uses the following equation:

$$\Delta Z_t = \beta + \theta_{yt-1} + \beta T + \sum_{j-1}^{k} \vartheta_j \Delta Z_{t-j-1} + \varepsilon_t \quad (1)$$

Where Z represents the series at period t, β indicates coefficient, k represents the lags and ε_t is error term. Therefore, the rule for rejecting the null hypothesis is that when the value of ADF is below the critical value, and the conclusion here is that there is the presence of unit root in the series. While the rule for not rejecting the null hypothesis is when ADF test value is above the critical value. This indicates that there is an absence of unit root in the series.

The Phillip Perron (PP) test adopted the Kemel Newey-West statistics that possess an advantage of correcting higher order autocorrelation and likely problem of heteroscedasticity in the series.

The PP test is expressed in the equation below:

$$\delta^2 = T^{-1} \sum_1^T \bar{e}_r^2 + 2T^{-1} \sum_{t-1}^{l} w(t,l) \sum_{r=t+1}^{l} \bar{e}_t \bar{e}_{t-1} \quad (2)$$

Where w(r, l) = 1[t/ (1+l)] and l is lags. If the computed PP value is lower the critical value, the decision is that the null hypothesis cannot be rejected and it is concluded that there is a presence of unit root in the series. In the case PP value is above the critical value the null hypothesis is rejected, and the conclusion is that there is an absence of unit root in the series.

Model for Empirical Analysis

The study uses a modified version of the model from Dogan and Turkekul (2015) for the association between CO_2 emissions and other independent variables as expressed in equation (3).

$$CO_2 = f\,(CO_2, GDP, FD, EC, FDI) \quad (3)$$

The variables CO_2, GDP, FD, EC, and FDI represent carbon emissions, economic growth, financial development, energy consumption, and foreign direct investment, respectively. The study uses Autoregressive Distributed Lag (ARDL) to determine the long-run relationship between these variables. ARDL bounds testing method was offered by Pesaran *et al.* (2001), and it has several advantages over other traditional techniques. The technique can be applied in the case variables are I (0), I (1) or are in mixed and therefore, it is appropriate for this study. The models can be expressed as:

$$\Delta LCO_{2t} = \beta_0 + \sum_{j=1}^{n} \beta_1 \Delta LCO_{2t-j} + \sum_{j=0}^{n} \beta_2 \Delta LGDP_{t-j} + \sum_{j=0}^{n} \beta_3 \Delta LFD_{t-j} + \sum_{j=0}^{n} \beta_4 \Delta LEC_{t-j} + \sum_{j=0}^{n} \beta_5 \Delta LFDI_{t-j} + \alpha_1 LCO_{2t-1} + \alpha_2 LGDP_{t-1} + \alpha_3 LFD_{t-1} + \alpha_4 LEC_{t-1} + \alpha_5 LFDI_{t-1} + \varepsilon_t \quad (4)$$

In equation (4), ε represents the error term, t denotes the time trend, and Δ indicates the first difference operator. Lag selection is built on the Akaike information criteria (AIC). Moreover, the decision concerning the long run depends on F-statistic. The null hypothesis that no cointegration among the variables is indicated by $H_O : \gamma_1 = \gamma_2 = \gamma_3 = \gamma_4 = \gamma_5 = 0$ while the alternative hypothesis is that the variables have a long-run relationship, specified as H_1: $\gamma_1 \neq \gamma_2 \neq \gamma_3 \neq \gamma_4 \neq \gamma_5 \neq 0$. Pesaran *et al.* (2001) formulated two critical values; the lower critical bound value (LCB) and the upper critical bound value (UCB). Therefore, if F statistic is greater than the UBC implies rejection of the null hypothesis, and it is concluded that cointegration exists between the variables. However, if F statistics is lower than the LCB suggests that the null hypothesis cannot be rejected and it is concluded that cointegration does not exist between the variables. Moreover, the estimated dynamic error correction model determines the short run and long run associations between the variables. The significant negative value of the error correction term (ECT) further endorses the presence of a long-run relationship.

Result and Discussions

This section presents the empirical results and discusses the findings of the study. For good econometric estimation, there is a need to check the stationarity of the data. Therefore, the unit root test was conducted using ADF and PP tests. The estimation of the ADF is built on Schwarz Information Criterion (SIC) while the PP estimate is built on Kemel Newey West bound selection. Table 2 depicts the unit root tests result in for both ADF and PP test. The results suggest that some of the variables are stationary at I(0) while others are found to be stationary at I(1). No variable among them are found to be stationary at I(2), thus, the ARDL bound testing method is appropriate as a technique to analyze these variables.

Table 2: Results of Unit Root test

Variable	ADF LEVEL		PP LEVEL		ADF First Diff		PP First Diff	
LCO2	-1.13536	(0.6898)	-1.16326	(0.6782)	-5.55675	(0.0000)	-5.56751*	(0.0000)
LGDP	-2.32518	(0.3963)	-3.79907**	(0.0293)	-6.66458*	(0.0000)	-	
LFD	-2.50746	(0.1229)	-2.28378	(0.1829)	-5.01692*	(0.0003)	-7.88251*	(0.0001)
LEC	-2.59713	(0.1037)	-2.64240	(0.0950)	-5.86078*	(0.0000)	-6.68993*	(0.0000)
LFDI	-3.08158**	(0.0378)	-3.08158**	(0.0378)	-		-	

Source: Author's Compilation using E-views

Notes: * and ** represents statistically significance at 1 and 5 percent level. Figures in parenthesis represent probability.

Table 3 presents the result of the bound test for the existence of cointegration. The bound test results confirm the presence of long-run association among the variables since the value of F-statistic is greater than the upper bound critical values at 1 % significance level.

Table 3: ARDL Bound test result

	1%		5%	
F-statistics	I(0)	I(1)	I(0)	I(1)
11.04	3.74	5.06	2.86	4.01

Source: Author's Compilation using E-views

Table 4 shows the short run and long run estimated results. The short-run analysis indicates that all the variables are positive and significant in explaining the carbon dioxide emissions in Nigeria. Similarly, the result shows that it takes 89.2 percent to adjust to long-run equilibrium, with the coefficient of adjustment term negatively significant at 1 percent. In addition, the long run estimate reveals that LEG, LFD, and LEC are positive and significant in influencing carbon dioxide emissions. However, LFDI is not significant in explaining carbon dioxide emissions in Nigeria. The finding indicates that A 1 percent increase economic growth by results to 0.43 percent rise in carbon dioxide emissions. This implies that higher economic growth is associated with the 0.43 percent increase in carbon dioxide emissions. The positive relationship exists between economic growth, and carbon dioxide emissions is not surprising as the recent diversification policy has promoted the productivity of the manufacturing sector and consequently accelerates the level of CO2 emissions in Nigeria. This finding is consistent with the result obtained by previous studies (Al-mulali & Ozturk, 2015; Heidari *et al.*, 2015; Jebli *et al*., 2017). Likewise, a 1 percent increase in financial development leads to a rise in carbon dioxide emissions by 0.79 percent. The result also indicates that a 1 percent rise in energy consumption result leads 0.13 percent rise in carbon dioxide emissions.

Table 4: Short Run and Long Run Results

ARDL estimation	Coefficients	SD Errors	t-Statistics	Prob
Short run estimates				
ΔLEG	3.133195*	0.473563	6.616221	0.0001
ΔLFD	0.976915*	0.148448	6.580869	0.0001
ΔLEC	0.097615*	0.030468	3.032334	0.0126
ΔLFDI	0.229524*	0.077198	2.973185	0.0140
ECT(-1)	-0.892748	0.161743	-4.475251	0.0015
Long run estimates				
LEG	0.432193**	0.137900	3.134103	0.0106
LFD	0.079866*	0.186425	4.284076	0.0016
LEC	0.131444*	0.039431	3.333548	0.0076
C	5.316160	1.634249	3.252968	0.0087

Source: Author's Compilation using E-views

Notes: * and ** represents statistically significant at 1 and 5 percent levels

Table 5 presents the post-estimation diagnostic checks. The result indicates that the estimated is free from problems Heteroskedasticity, serial correlation, and the errors are normally distributed. In addition, the study uses CUSUM and CUSUM square to know the stability of the model. Figure 1 and 2 present the CUSUM and CUSUM square; the figures show that the model is stable as CUSUM and CUSUM square lines are not outside the 5 percent critical line.

Table 5; Post Estimation Diagnostic Checks

Test Type	F-statistics	Probability	Result
Breusch-Pagan Test.	0.369897	0.9702	No Heteroskedasticity
Breusch-Godfrey Test	6.001145	0.2256	No Serial Correlation
Jarque-Bera	1.18607	0.5541	Normally Distributed

Source: Author's Compilation using E-views

Conclusion and Recommendations

This study examined the influence of economic growth, financial development, energy consumption, and FDI on carbon dioxide emissions in Nigeria by employing the ARDL bound testing method. The results of the bound test indicate the existence of long-run association among the variables under consideration. The short-run estimates show that all the variables are positively related to carbon dioxide emissions. The long-run analysis shows that economic growth, financial development, energy consumption are significant and positive in determining carbon dioxide emissions in Nigeria.

The implication of the results obtained is that since economic growth is linked to the concentration of CO_2 emissions in Nigeria, policymakers should consider low emissions technology and use other forms of energy like solar, wind and bioenergy to lessen (CO_2 emissions) damaging effect. The positive association found between economic growth and CO_2 emissions is consistent with the findings of previous studies (Omri, 2014; Salahuddin & Gow, 2014). Finally, there is a need for future studies to consider other factors that may influence environmental quality.

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Appendix: Stability Test

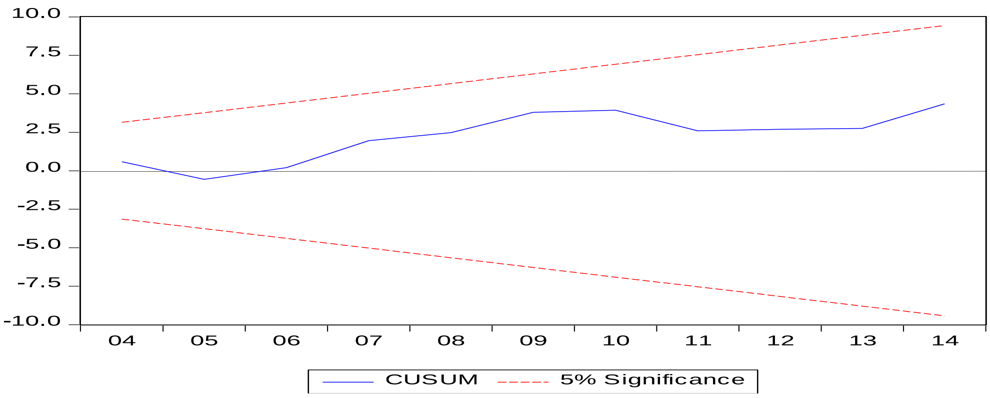

Fig. 1: CUSUM test for stability

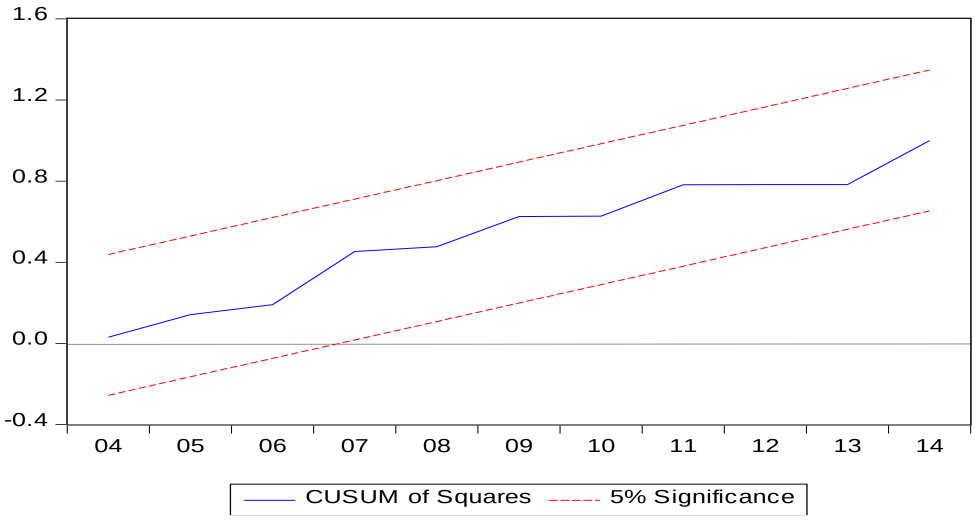

Fig. 2: CUSUM Square Test for Stability