JDE (Journal of Developing Economies)
https://e-journal.unair.ac.id/JDE/index

FINANCIAL MARKET DEVELOPMENT AND CO2 EMISSIONS NEXUS IN NIGERIA: AN APPLICATION OF ARDL APPROACH

Kabiru Saidu Musa*[1]
Sulaiman Chindo[2]
Rabiu Maijama'a[3]

[1]M.Sc. Economics Student, Department of Economics, Faculty of Social Sciences, Bauchi State University Gadau, P.M.B 065, Yuli Campus, Bauchi-Nigeria.
[2]Lecturer, Department of Economics, Faculty of Social Sciences, Bauchi State University Gadau, P.M.B 065, Yuli Campus, Bauchi-Nigeria.
[3]NNPC Retail Sales Representative, Nigeria National Petroleum Corporation, NNPC Towers, Central Business District, P.M.B. 190, Garki, Abuja-Nigeria.

ABSTRACT

The paper investigated the impact of financial development on CO2 emissions in Nigeria from 1981 to 2019. In the process of investigating the impact, Augmented Dickey-Fuller and Philip Perron, as well as the Zivot-Andrew structural breaks, unit root tests were applied. Their results indicated that financial development, level of income, and CO2 emissions were stationary at the first difference and that of Zivot-Andrew structural breaks indicated a mixture of integration. Cointegration relationship among the variables was established through autoregressive distributed lag model bounds test. The autoregressive distributed lag model long-and-short run models results indicated that financial development and income level significantly negatively impact the CO2 emissions. The suggestion based on these results is that financial development and income level help in financing clean projects in the long-and-short runs. The Granger causality result revealed bidirectional causality from financial development to CO2 emissions, income level to CO2 emissions, and financial development to income level. The variance decomposition analysis indicates that financial development and income level have contributed less to CO2 emissions, and impulse response function results revealed that CO2 emissions respond negatively to shocks in financial development and income level. Therefore, we recommend expanding the Nigerian financial market in financing clean projects for a clean environment alongside checking income generation activities that bring about emissions of CO2, such as burning trees for charcoal production in the forest, among others.

Keywords: Financial market development, CO2 emissions, ARDL approach
JEL Classification: G20, Q53, C32

ARTICLE INFO

Received: October 5th, 2020
Revised: March 16th, 2021
Accepted: May 6th, 2021
Online: June 1st, 2021

*Correspondence:
Kabiru Saidu Musa
E-mail:
kabirusaidumusa@gmail.com

To cite this document: Musa, K. Saidu., Chindo, Sulaiman., & Maijama'a, Rabiu. (2021). Financial Market Development and Co2 Emissions Nexus in Nigeria: An Application of ARDL Approach. *JDE (Journal of Developing Economies),* Vol. 6(1), 92-113

JDE (Journal of Developing Economies) p-ISSN: 2541-1012; e-ISSN: 2528-2018
DOI: 10.20473/jde.v6i1.22448

Introduction

The evolution of the financial development concept started in the 6th century BC-15th century A.D., and the concept continued to widen up to the present days, passing through several periods and terminological modifications beginning with the basic as a financial market to current clarification of financial development due to purposes and results (Čižo, Lavrinenko, & Ignatjeva, 2020). One of the most excellent millennium development goals is providing a clean or fresh environment in the world to benefit from contemporary and clean technologies. If not, the technologies that promote pollution emissions would become harmful to the globe in pollution and fair provision of short-term welfare to the societies. For sustainability in the long-term, these technologies from clean sources are crucial in realizing a clean environment. Thus, for the advancement of clean technologies, the financial sector needs to categorize the loans. Otherwise, the emissions of pollution and financial market development will create unmaintainable development in the globe due to ignorance (Claessens & Feijen, 2006;Mahmood, 2020).

Accompanied by economic development and growing energy consumption, several additional forces within a nation substantially affect the environment. One among these forces is the impact of financial market development. As stated by Frankel & Romer (1999), financial markets might help in achieving a healthier development in the nation alongside a rising need for a cleaner environment due to more development. However, Zhang (2011) claimed that financial market development would increase investment and consumer credit. Due to financial market development, the growing economic events might emit pollution, which would convert to degrading the environment while regarding economic growth and financial market development. The actual positive environmental influence could be anticipated if the method and structural possessions are prevailing on the measure consequence, and the contrary environmental consequence may be anticipated then (Mahmood, Furqan, & Bagais, 2019). The positive environmental part of financial market development proved that it helps achieve clean environmental technologies and inventions with financial market development, raising the capacity of innovation and industrial size to invents effective technology, decreasing the nation's levels of pollution (Birdsall & Wheeler, 1993).

To the extent of this argument, Shahbaz et al. (2013) examined the connection between financial market development and environmental pollution in Malaysia's case. They reported a negative effect of financial market development, and therefore the study corroborates the argument of the positive environmental influence of financial market development. Another investigation revealed a positive effect of financial market development in achieving environment quality in the case of the leading emitter of CO_2 China and concluded that financial market development had decreased the level of pollution (Jalil & Feridun, 2011). Zhang (2011) reported that financial market development caused pollution in investigating the relationship between financial market development and pollution. Moreover, more recently, Mahmood (2020) reported that financial market development had an insignificant influence on the level of emissions in G.C.C. countries. Financial market development increases the growth of industries and urbanization, which is measured as necessary for the complete economic growth; however, it can possess some harmful effect in pollution emission when the environment's side is neglected. Therefore, it becomes significant to examine the impact of financial market development on environmental pollution to control the dirty industrial growth, which is financed to raise their business actions which consequently caused damage to the environmental health. In line with the above argument and the paper's background, our objective is to explore the impact of financial market development on CO_2 emissions. Testing the objective would aid in filling the literature gap in the Nigerian environment.

Therefore, based on this background, the paper is structured as follows. This section is section two that provides the review of related literature on the relationship. Section three offered data description and research methodology. Section four provides the empirical results and discussions of findings. Section five concentrated on the conclusion and policy recommendation.

Literature Review

The review of related literature in this paper covered studies on financial market development and CO_2 emissions relationship together with those studies on CO_2 emissions and other related variables both within and outside the country of study.

In their investigation for the possible existence of the EKC hypothesis for 1971 to 2014 using the case of Saudi Arabia, Mahmood et al. (2018) analyzed the asymmetric influence of financial market development and energy consumption on CO_2 emissions. The outcome indicated the existence of EKC and long-run asymmetric influence of financial market development together with short-run and long-run asymmetric effect of energy consumption on CO_2 emissions. Again, financial market development is accountable for environmental degradation, and reducing energy consumption is found to support CO_2 emissions. However, in the Turkish economy, Çetin & Ecevit (2017) studied the effect of financial development on CO_2 emissions from 1960 to 2011. The data was analyzed using ARDL and VECM Granger causality test. The results revealed that financial development, trade openness, economic growth affected CO_2 emissions in the long-run, and long-run causality exists from financial development, trade openness, and economic growth to CO_2 emissions. The results imply that the EKC hypothesis exists and that financial and economic development has arisen due to the environment's degradation.

Using the case of 12 MENA nations and applied the G.M.M. technique in the data estimation for the 1990-2011 period, Omri et al. (2015) examined the connection among financial development, trade openness, CO_2 emissions, and economic growth. The result indicated a negative connection between financial development and CO_2 emissions in Jordan, and again in Qatar, CO_2 emissions have a positive correlation with financial development. Shahzad et al. (2014) investigated the link between economic growth, energy consumption, financial development, trade openness, and CO_2 emissions for the sample duration of 1973 to 2011 in Pakistan. The sample period data was analyzed using ARDL bounds for cointegration, fully modified, and dynamic ordinary least squares. The result revealed that there exists a bi-directional long-run causal relationship between financial development and CO_2 emissions.

In another development, Shahbaz et al. (2013) studied the relationship between financial development and CO_2 emissions with the help of energy consumption, economic growth, and CO_2 emissions in the case of Malaysia between the period of 1971 to 2011 and the data for the sample period was analyzed using ARDL and VECM approaches. The long-run result indicated that financial development reduces CO_2 emissions, and bidirectional causality exists between financial development and CO_2 emissions. However, in the South African economy, Shahbaz, Kumar Tiwari, & Nasir (2013) examined the influence of coal consumption, financial development, trade openness, economic growth on environmental pollution for the sample period of 1965 to 2008 and applied ARDL VECM procedures. The analyses revealed that financial development has a long-run negative impact on economic growth and that unidirectional causality exists from CO_2 emissions to financial development.

Mahmood et al. (2018) investigated the environmental impact of financial market development, foreign direct investment, trade openness on CO_2 emissions together with the EKC hypothesis in the six East Asian nations for the 1991-2014 period using the technique of spatial econometrics to reflect the neighboring nations' spillover effect. The result indicated a supportive spillover effect from the neighboring nations' CO_2 emissions, financial market development, foreign direct investment, trade openness, and energy intensity. They were accountable for the resident environmental degradation and neighboring nations' financial market development's significant positive effect on CO_2 emissions. In their determination for the influence of economic growth and energy consumption on environmental pollution, Maijama'a & Musa (2020) applied the ARDL procedure on the time series data spanning the 1981-2014 period of the Nigerian economy. Their result from the ARDL procedure indicated that all the series are cointegrated. Energy consumption and economic growth have significantly signed positively with environmental pollution, whereas negative and significant signed was witnessed between crude oil price and environmental pollution in the long-and-short runs.

In another development using the same case study and applied ARDL approach, Maijama'a & Musa (2020) analyzed the effect of crude oil price and urbanization on the level of environmental pollution for the 1981-2016 periods. The analysis revealed that all the series were cointegrated and that crude oil price and foreign direct investment have significantly influenced environmental pollution negatively in both long-and-short run periods. However, a significant favorable influence was witnessed between urbanization and environmental pollution. Ma & Fu (2020) document that financial development positively affects energy use through financial institutions and financial markets in developing countries. However, they do not identify this effect in the case of developed countries. The authors employ the G.M.M. approach and investigate different periods of 1991-2014, 1981-2014, 1970-2014, and 1960-2014 as the whole sample covered 120 countries.

On the other hand, in modeling the relationship between economic growth and financial development, most studies reported a positive connection between the two variables implying that financial development promotes economic growth. Among the studies that reported the existence of the positive relationship between financial development and economic growth using different methodologies in different case studies to include Alrifai et al. (2020); Durusu-Ciftci et al. (2017); Lenka & Sharma (2017); Kazar & Kazar (2016); Xiang & Dongye (2016); Valickova et al. (2015); Lenka (2015); Mercan & Gocar (2013); Rosalia (2013); Bittencourt (2012); Choong & Chan (2011). Their results indicated that financial development possessed some positive sound effect on the G.D.P. per capita of these nations.

Therefore, based on the sufficient literature reviewed, the general studies present conflicting findings regarding the exact relationship between financial development and CO_2 emissions. The studies that specifically looked at the relationship between financial development and CO_2 emissions in the Nigerian economy are relatively scarce. Hence, there is a sufficient gap in the prevailing literature in Nigerian studies to investigate the impact of financial development on CO_2 emissions.

Data and Research Methods

The data and methodology in this section are organized in sections. Section one focused on the source of data, justifications, and variables' measurements. Section two presented the general paper methodology.

Data Source and Variables Measurement

The variables included in this study are financial market development, CO_2 emissions, and level of income for the 1981-2018 periods. The study period's choice was highly influenced by the data available on all these variables from two sources. The remaining required information concerning the variables' measurement, justification, and extracted sources are offered in Table 1.

Table 1: Variables Measurement and Sources

Variables	Measurements	Justifications	Sources
F.D.	Credit to Private Sector (% of G.D.P.)	Janpolat et al. (2021); (Orji et al. (2019); Okoye et al. (2019) and Sulaiman (2014).	The World Bank (2020)
CO_2	CO_2 Emissions per capita	Shahbaz, Kumar Tiwari, et al. (2013); Shahbaz, Solarin, et al. (2013); Mahmood et al. (2018) and Mahmood (2020)	Crippa et al. (2019)
IC	GDP per capita (Constant 2010 US$)	Janpolat et al. (2021); Sulaiman (2014).	The World Bank (2020)

Methodology

The study's primary focus is to determine the effect of financial development on CO_2 emissions in Nigeria within the sample period of 1981 to 2018. A theoretical framework for this research is the environmental Kuznets theory. According to the environmental Kuznets theory, industrial advancement initially causes environmental destruction, but after a certain degree of economic growth, a society's interaction with the environment improves, and environmental degradation levels decrease. Therefore, to derive the empirical model connecting the variables of interest, line with previous studies such as Ang (2008), Halicioglu (2009) and later on, Shahbaz & Lean (2012) utilized a single equation model to study the relationship between economic growth, energy consumption, and CO_2 emissions. Later on, Tamazian, Chousa, & Vadlamannati (2009) and Jalil & Feridun (2011) augmented the single equation model by including financial development as a potential determinant of CO_2 emissions. Therefore, following these studies, we use financial development and income levels within a multivariate framework in Nigeria. To derived the model equation, we have followed the empirical economic growth model given as Q = F (K, L). In our modification of the model, Q is replaced with CO_2, F.D. replaced K and I.C. replaced L, and the final modified estimable model is given Equation 1.

$$CO_{2t} = f(FD_t, IC_t) \tag{1}$$

CO_{2t} represents the carbon emissions; FD_t represents financial development at time t; IC_t represents the level of income at time t; t represents 1981-2018 periods.

Equation 1 given above is the functional equation. To transform it into the econometric model, we include the white noise, and the white noise is expected to be generally distributed as offered in Equation 2. Again, for a straightforward interpretation of the coefficients in elasticity form, we have introduced the natural logarithm in Equation 2 following the studies of Epule, Peng, & Lepage (2015); Ahmed et al. (2015); Sulaiman & Abdul-Rahim (2018); Musa et al. (2019). The model equation is given as follows.

$$\ln CO_{2t} = \theta_0 + \theta_1 \ln FD_t + \theta_2 \ln IC_t + \varepsilon_t \tag{2}$$

Ln is the natural logarithm; θ_0 represents the drift parameter; $\theta_1 \& \theta_2$ represents the coefficients of explanatory variables to be estimated; F.D.A. represents financial development; I.C.T. represents the level of income; ε_t represents the disturbance term.

Unit Root Tests

When the given variables possessed unit root, it is indicated that the variable is non-stationary, and when non-stationary variables are regressed on other non-stationary series, the generation of spurious or non-sense regression results is guaranteed. Therefore, to dodge all possibilities of generating spurious results, this paper utilized the convectional Augmented Dickey-Fuller (Dickey & Fuller, 1981). Besides, Phillips & Perron (1988) unit root tests and Zivot & Andrews (1992) structural breaks unit root test is also engaged as a robustness check to the result A.D.F. and P.P. unit root tests. The A.D.F. modeling is presented in Equation 3.

$$\Delta Z_t = \beta_1 + \phi Z_{t-j} + \sum_{j=1}^{m} \theta_j \Delta Z_{t-j} + \varepsilon_t \tag{3}$$

We test the null hypothesis, H.N.: $\gamma = 0$ for non-stationary as against the alternate hypothesis H.A.: $\gamma \leq 0$ for the stationary series.

After this stage for unit root, we continued to test for cointegration association among our variables. For this reason, we are following the Autoregressive Distributive Lag (ARDL) bound test advanced by Pesaran et al. (2001) in a subsequent system:

$$\begin{aligned} LnCO_{2t} &= \theta_0 + \theta_1 \ln CO_{2t-j} + \theta_2 \ln FD_{t-j} + \theta_3 \ln IC_{t-j} + \\ &\sum_{j=1}^{k} \partial_{1j} \ln CO_{2t-j} + \sum_{j=1}^{k} \partial_{2j} \ln FD_{t-j} + \sum_{j=1}^{k} \partial_{3j} \ln IC_{t-j} + \varepsilon_{1t} \end{aligned} \tag{4}$$

We test for the existence of a long-run relationship using the null hypothesis that says no cointegration relationship among the series given as H.N.: $\theta_1 = \theta_2 = \theta_3 = 0$. The alternative hypothesis says there is a cointegration relationship among the variables given as H.A.: $\theta_1 \neq \theta_2 \neq \theta_3 \neq 0$. According to Pesaran et al. (2001) a cointegration relationship among the variables of interest exists when the calculated F-statistics is greater than the upper bonds critical values only. Therefore, we reject the null hypothesis. However, when the estimated F-statistics is less than the lower bond critical values, then there is no cointegration relationship among the variable, and we accept the null hypothesis. On the other hand, if the calculated F-statistics is greater than the lower bond critical values but is less than the upper bond critical values, the result is inconclusive.

Following the cointegration relationship among our variables, we proceeded to test for the long-run and short-run coefficients together with the error correction coefficient that determined the speed of adjustment back to the equilibrium position. However, the long-run and short-run coefficients' generation depends mainly on the pie (π) being negative, less than one, and statistically significant. Also, as the coefficients of the pie (π) have satisfied these three conditions, it is said to substantiate the existing long-run association in the model as given in Equation 5.

$$LnCO_{2t} = \theta_0 + \theta_1 \ln CO_{2t-j} + \theta_2 \ln FD_{t-j} + \theta_3 \ln IC_{t-j} + \sum_{j=1}^{k} \partial_{1j} \ln CO_{2t-j} + \sum_{j=1}^{k} \partial_{2j} \ln FD_{t-j} + \sum_{j=1}^{k} \partial_{3j} \ln IC_{t-j} + \pi ECT_{t-1} + \varepsilon_{1t} \quad (5)$$

Granger Causality Technique

After establishing the series's long-run connection, the paper continued examining the causal relationship between the series with the Granger causality test's help. Granger (1969) supported this test such that series Y Granger caused X if series Y can be projected with the help of better certainty using previous values of series X and ceteris paribus. We have utilized the following V.A.R. model given in Equations 6, 7, and 8, respectively.

$$X_t = \chi_1 + \sum_{j=1}^{k} \phi_1 Y_{t-j} + \sum_{p=1}^{k} \phi_2 Z_{t-p} + \sum_{q=1}^{k} \phi_3 X_{t-q} + \mu_{1t} \quad (6)$$

$$Y_t = \chi_0 + \sum_{j=1}^{k} \chi_1 X_{t-j} + \sum_{p=1}^{k} \chi_2 Z_{t-p} + \sum_{q=1}^{k} \chi_3 Y_{t-q} + \mu_{2t} \quad (7)$$

$$Z_t = \chi_2 + \sum_{j=1}^{k} \partial_1 X_{t-j} + \sum_{p=1}^{k} \partial_2 Y_{t-p} + \sum_{q=1}^{k} \partial_3 Z_{t-q} + \mu_{3t} \quad (8)$$

Where series X, Y, and Z represent the CO_2 emissions, financial development, and income level, respectively. From Equations 6, 7, and 8, we test for $H_0 : \sum_{j=1}^{k} \phi_1 = 0$; $H_0 : \sum_{j=1}^{k} \chi_1 = 0$ and $H_0 : \sum_{j=1}^{k} \partial_1 = 0$ respectively.

The decision regarding the acceptance or rejection of null and alternative hypotheses is based on the following two situations:

1. We reject each of the H_0 given above only if the calculated F-statistic is larger than the critical values at a certain level of significance. In other words, we do not reject H_0, and rejecting the H_0 in Equations 6, 7, and 8 suggested that financial development and level of income Granger caused CO_2 emissions. The previous values of financial development and level of income significantly project CO_2 emissions.
2. Similarly, rejecting H_0 in Equations 6, 7, and 8 also suggested that CO_2 emissions Granger caused financial development and income level. Previous values of CO_2 emissions could be employed to project financial development and income levels in question.

Incorporating our three variables that include CO_2 emissions, financial development, and level of income into the model, Granger causality equations are given in Equations 9, 10, and 11, respectively, based on the vector autoregressive (V.A.R.) system of the equation as follows:

$$\ln CO_{2t} = \theta_0 + \sum_{j=1}^{k} \theta_{1t} \ln CO_{2t-j} + \sum_{j=1}^{k} \theta_{2t} \ln FD_{t-j} + \sum_{j=1}^{k} \theta_{3t} \ln IC_{t-j} + \mu_{1t} \quad (9)$$

$$\ln FD_{2t} = \chi_0 + \sum_{j=1}^{k} \chi_{1t} \ln CO_{2t-j} + \sum_{j=1}^{k} \chi_{2t} \ln FD_{t-j} + \sum_{j=1}^{k} \chi_{3t} \ln IC_{t-j} + \mu_{2t} \quad (10)$$

$$\ln IC_t = \pi_0 + \sum_{j=1}^{k} \pi_{1t} \ln CO_{2t-j} + \sum_{j=1}^{k} \pi_{2t} \ln FD_{t-j} + \sum_{j=1}^{k} \pi_{3t} \ln IC_{t-j} + \mu_{3t} \tag{11}$$

Ln is the natural logarithm sign; 1985-2019 is presented by t; $\theta_1 ... \theta_3; \chi_1 ... \chi_3$ *and* $\pi_1 ... \pi_3$ are the causality coefficients to be estimated in the three equations; ∑ represent the summation and $\mu_{1t} ... \mu_{3t}$ are the disturbance terms.

Finding and Discussion

This section offered the empirical results and discussions in graphical presentation of the series, descriptive, and correlation analyses. Also, the unit root test results' presentation using the traditional unit root tests and structural breaks unit root to determine the order integration of the series, the optimum lag selection test, ARDL bounds test, Granger causality test result, and diagnostic tests.

The graphical presentation of CO_2 emissions, financial development, and income level are given in Figure 1. The trends of CO_2 emissions show a decreasing fluctuating trend for the period under study, whereas financial development indicated an increasing fluctuating trend throughout the study period. However, the level of income trend possessed some form of fluctuations from 1985 to 2000. From there, the trend maintained an upward movement for the rest of the period. The rest of the interpretation regarding the study period is presented in Figure 1.

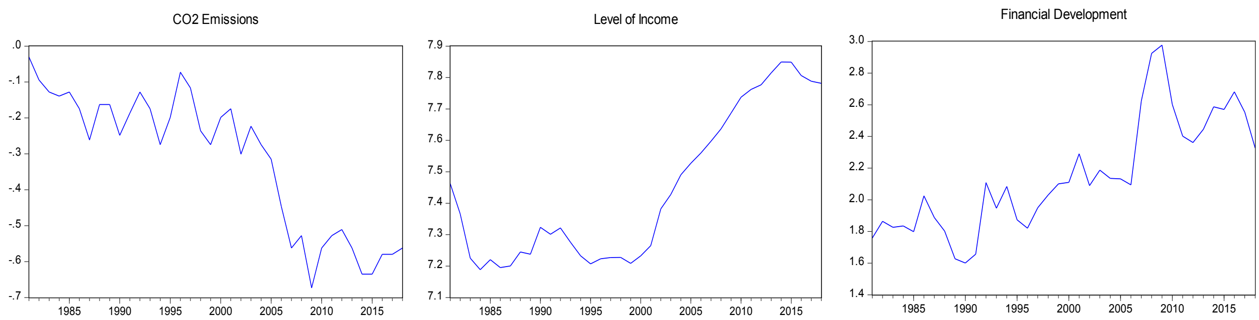


Figure 1: Trends of CO2 Emission, Level of Income, and Financial Development (1985-2019)
Source: EDGAR &The World Bank (2020)

After the graphical presentation of financial development, level of income, and CO_2 emissions for the period under investigation as offered in Figure 1, here comes the presentation of descriptive and correlation analyses given in Table 2. The areas described include the average values given as the mean, the variable variation of variables more formally known as deviation, the measure of how positive or negative the variables are in terms of skewness, the measure of variables normality given as the Jarque-Bera values and their probability values given in bracket and lastly the total number of observations after the descriptive analysis followed by the correlation analysis offered in the lower part of Table 2. The result indicated a negative correlation running between the independent variables and the dependent variable, as shown by the negative values of -0.868 and 0.896 for the financial development and income level. Therefore, these negative values entail that an increase in financial development and income level would reduce the level of CO_2 emissions for the period under study. The rest of the analysis result is presented in Table 2.

Table 2: Descriptive Statistics and Correlation Analysis

Variables	$\ln CO_{2t}$	$\ln FD_t$	$\ln IC_t$
Mean	-0.316	2.149	7.443
Standard Deviation	0.194	0.354	0.238
Skewness	-0.469	0.556	0.517
Jarque-Bera	4.030 (0.133)	2.316 (0.313)	4.548 (0.102)
Observations	38	38	38
$\ln CO_{2t}$	1.000	-0.868	-0.896
$\ln FD_t$		1.000	
$\ln IC_t$			1.000

Source: Author Calculation

Unit Root Tests Results

The Augmented Dickey-Fuller (A.D.F.) and Philip Perron (P.P.) unit roots tests were engaged in ascertaining the order of integration of the series and their estimation results offered in Table 3. The results revealed that under A.D.F. and P.P. unit root tests, all the series were not stationary at the level. This result makes it impossible to reject the null hypothesis of the non-stationary series. However, these variables became stationary after first differencing, and this makes it possible to reject the null hypothesis of the non-stationarity series. Therefore, all the series are integrated of order one or popularly known as I(1) variables. The two tests' results indicated that the ARDL approach is more appropriate to be conducted. The bounds test for cointegration is efficient to handle the cointegration relationship between the series.

Table 3: Unit Root Tests Results

	ADF		PP	
Variables	**Constant**	**Constant & Trend**	**Constant**	**Constant & Trend**
At Level				
$\ln CO_{2t}$	-1.285 (0.626)	-2.531 (0.312)	-1.145 (0.687)	-2.490 (0.330)
$\ln IC_t$	-0.881 (0.782)	-1.510 (0.806)	-0.264 (0.920)	-3.172 (0.105)
$\ln FD_t$	-1.728 (0.409)	-4.000 (0.018) **	-1.636 (0.454)	-2.295 (0.425)
At 1st Difference				
$\ln CO_{2t}$	-6.382 (0.000) ***	-6.287 (0.000) ***	-8.526 (0.000) ***	-8.391 (0.000) ***
$\ln IC_t$	-3.825 (0.006) ***	-3.741 (0.032) **	-3.825 (0.006) ***	-3.741 (0.032) ***
$\ln FD_t$	-5.430 (0.000) ***	-5.317 (0.000) ***	-7.890 (0.000) ***	-7.753 (0.000) ***

Note: *** stands for the 1% level of significance, respectively

** stands for the 5% level of significance, respectively

Source: Author Calculation

Knowing the integration of the series using the traditional A.D.F. and P.P. unit root tests does not guarantee that the result is free from structural breaks. To handle the stationarity test with the possible existence of structural breaks in the series, we have employed the Zivot-Andrew structural breaks unit root test. The result of utilizing the test is given in Table 4. The result of the test indicated that CO_2 emissions and financial development were stationary at the level. Therefore they are said to be integrated of order zero or I(0). In contrast, the level of income is the only variable not stationary at level but became stationary after first differencing and is said to I(1). The remaining interpretation of the result can be obtained in Table 4.

The result of the Zivot-Andrew structural breaks unit root test also supported the application of the ARDL bounds approach.

Table 4.Zivot-Andrew Structural Breaks Unit Root Test Result

Variables	Constant	Break Date	Constant & Trend	Break Date
At Level				
$lnCO_{2t}$	-5.510 (0) ***	2006	-3.435 (0) *	1997
$lnIC_t$	-3.106 (2)	2002	-3.081 (2)	1995
$lnFD_t$	-6.113 (2) ***	2007	-4.430 (2) **	1990
At 1st Difference				
$lnCO_{2t}$	-6.820 (1) ***	2010	-6.236 (1) ***	2008
$lnIC_t$	-4.905 (1) *	2000	-4.277 (1) *	2010
$lnFD_t$	-6.113 (2) ***	2007	-4.430 (2) **	1990

Note: * stands for the 10% level of significance, respectively

** stands for the 5% level of significance, respectively

*** stands for the 1% level of significance, respectively

Source: Author Calculation

ARDL Bounds Test Result

After knowing the integrating order of the series employed in the study and before estimating the ARDL bounds test, short-run, and long-run models, respectively, we have determined the optimum lag lengths that are free from serial correlation, and the result is given in Figure 2. The result revealed that ARDL (2,0,0) is the best lag combination for our ARDL model estimation.

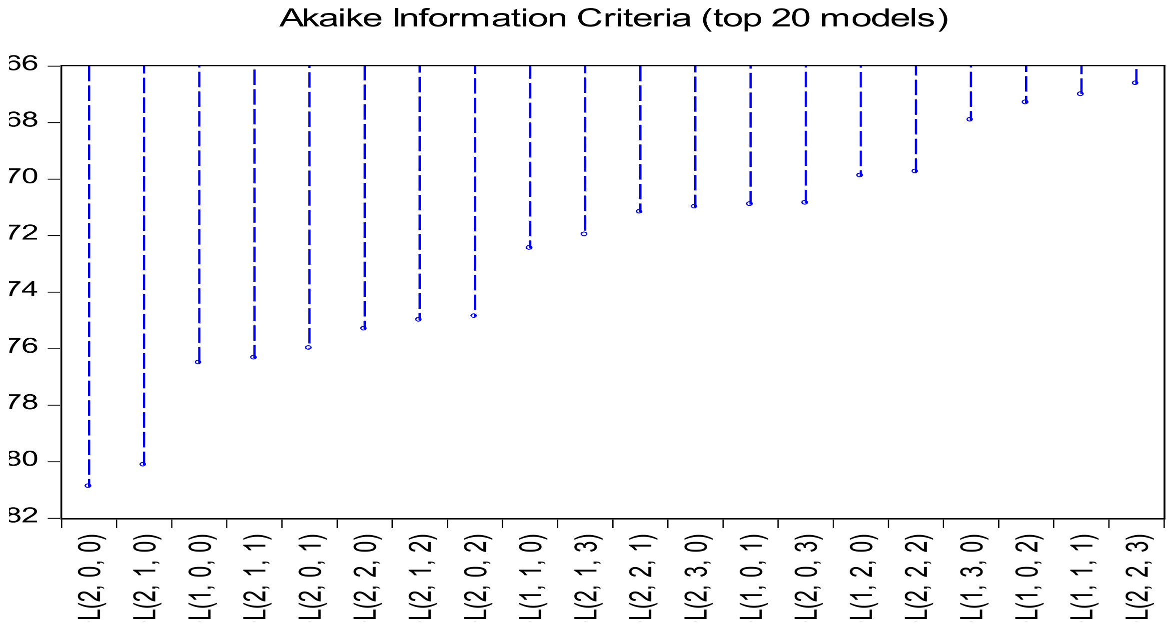


Figure 2: ARDL Model Selection Criteria Graph

After knowing the optimum lags combination of the ARDL to be 2,0,0 as given in Figure 2, here comes the estimation of the long-run equilibrium relationship among the variables, and the result of the estimation is given in Table 5. The estimation results revealed that all the variables have a strong cointegration relationship as indicated by the estimated F-statistic value of 6.143, which appears to be higher than lower and upper bounds critical values at 1 percent, regarded as more stringent. Therefore, all the series are highly cointegrated, and they move together in the long-run.

Table 5: ARDL Bound Test Result

Bound Test	Constant and No-Trend	
Equation Estimated:	$\ln CO_{2t} = f(\ln FD_t, \ln IC_t)$	
Optimum Lags:	(2, 0, 0)	
Model selection method: Akaike info criterion (A.I.C.)		
Estimated F-statistic	6.143^{**}	
Significance	**I(0)**	**I(1)**
10 percent	3.17	4.14
5 percent	3.79	4.85
1 percent	5.15	6.36

Note: ** stands for the 5% level of significance, respectively

Source: Author Calculation

ARDL Shot-and-Long Run Estimated Results

The existence of a cointegration relationship among the series given by the result of the bounds test in Table 5 necessitated estimating short-run, long-run, and error correction coefficients, respectively. The result indicated that financial development and income level have a significant negative impact on CO_2 emissions at a 1 percent level of significance. Precisely, a percentage change in financial development and level of income are associated with 0.136 and 0.502 percent decrease in CO_2 emissions in the short-run period. There is a strong influence of financial development and income level on CO_2 emissions in the long-run period, where financial development reduced CO_2 emissions by 0.150 percent and level of income reduced CO_2 emissions by 0.553 percent, respectively. These findings are regarded as a strong indication that financial development and income help clean project financing. The findings corroborate that of Mahmood (2020) for the United Arab Emirate, Shahbaz, Solarin, et al. (2013) for Malaysia, Jalil & Feridun (2011) for the Chinese economy, and Tamazian et al. (2009) for BRIC nations.

The coefficient of error correction term as reported in the lower part of Table 6 has satisfied all the three econometric conditions of being negative, less than one, and statistically significant. Therefore, these conditions' achievement is also a confirmation of a long-run equilibrium relationship among the series. Precisely, the error correction term coefficient of -0.908 signifies that there is a solid and fast speed of convergence in case of dynamic short-run disequilibrium back to the equilibrium position. The speed of convergence back to equilibrium position is approximately 91 percent every year within the sample study period. The coefficient of R-square in the lower part of Table 6 measured the number of variations or changes in the explanatory variable that is jointly explained by the explanatory variables in the model. In the ouR-square coefficient, 93 percent change in CO_2 emissions is explained jointly by the financial development and income level, implying that only 7 percent is captured by the error term. The F-statistic value measured all the independent variables' joint significance in explaining the dependent variable in an income level model. The estimated F-statistic is statistically significant, which indicated that financial development and income level are jointly significant in explaining changes in CO_2 emissions.

Table 6: ARDL Short and Long-Run Results

Dependent Variable = ln CO_{2t}		
Variables	**Coefficients**	**T-statistics [P-values]**
	Short-Run Relationship	
Δln CO_{2t}	0.240	1.681 [0.102]
$\Delta lnFD_t$	-0.136	-2.856 [0.007] ***
$\Delta lnIC_t$	-0.502	-4.222 [0.000] ***
ECM [-1]	-0.908	-5.518 [0.000] ***
	ECM = $lnCO_2 + 0.1502ln\ FD_t + 0.5531\ lnIC_t - 4.1153$	
	Long-Run Relationship	
Constant	4.115	-2.983 [0.005] ***
$lnFD_t$	-0.150	-7.695[0.000] ***
$lnIC_t$	-0.553	9.109 [0.000] ***
R-squared	0.925	
Adjusted R-squared	0.915	
F-statistic	96.147 [0.000] ***	

Note: *** stands for the 1% level of significance, respectively

** stands for the 5% level of significance, respectively

* stands for the 10% level of significance, respectively

Source: Author Calculation

The estimated models' coefficients reported in Table 6 are not reliable for policymaking if the coefficients are not subjected to diagnostic tests. To ascertain the reliability of these coefficients, we have engaged the serial correlation test, heteroscedasticity test, functional form test, normality test, and stability test, respectively. Their results are reported in Table 7. The result indicated that the null hypothesis of no serial correlation could not be rejected for the serial correlation test since the test's p-value is not significant. For heteroscedasticity, the null hypothesis of no heteroscedasticity could be rejected given that the test p-value is not significant. In the case of errors specification or misspecification in the model, the functional form test in the form of the RAMSEY Reset test revealed that the null hypothesis says errors are specified accepted since the p-value of the test is insignificant. Again, errors in the model are normally distributed, as shown by the insignificance of the normality test p-value. Lastly, the stability test via the CUSUM and CUSUM of squares indicated that errors are stable since the CUSUM and CUSUM of straight lines are within the 5 percent significance boundary. Therefore, in summary, our estimated model has passed the serial correlation, heteroscedasticity, functional form, normality test, and stability tests, respectively. The estimated coefficients are now safe and can be relied on for policymaking and other statistical inferences.

Table 7: Reliability Tests Result

Test Statistics	F-Version	LM-Version
1. Serial correlation	1.179 (0.321)	2.707 (0.258)
2. Heteroscedasticity	0.942 (0.452)	3.904 (0.419)
3. Functional Form	0.801 (0.377)	0.895 (0.377)
4. Normality	0.079 (0.960)	Not Applicable

Stability	
CUSUM	Stable
CUSUMSQ	Stable

1. Breusch-Godfrey Serial Correlation L.M. Test
2. Breusch-Pagan-Godfrey
3. Jarque-Bera
4. Ramsey RESET Test

Source: Author Calculation

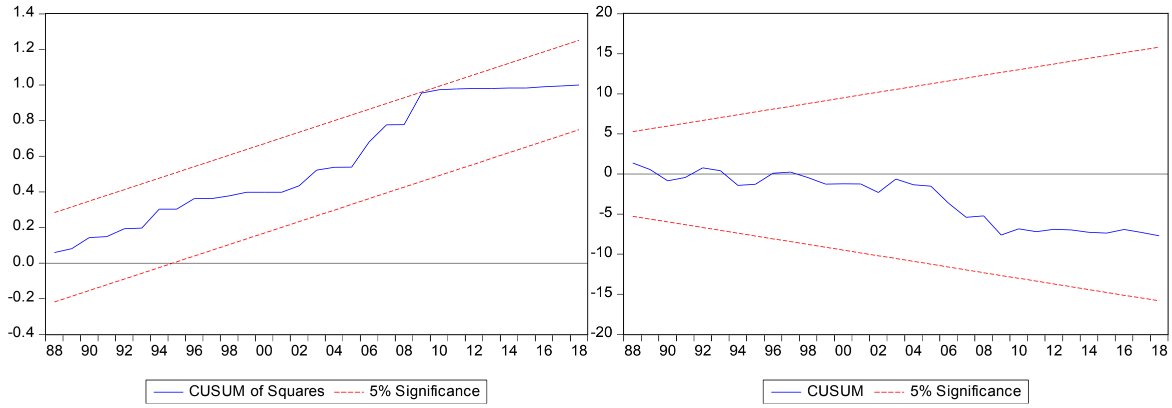


Figure 3.CUSUM and CUSUM of Square Plots for the Model Stability.

Robustness Checks Results

For robustness checks on the calculated coefficients of the long-run ARDL model, we have utilized the dynamic ordinary most minor (DOLS), fully modified ordinary least square (FMOLS), and the canonical cointegration regression (C.C.R.), respectively. The results are reported in Table 8. The three estimators' results indicated that the independent variables' coefficients are in line with their ARDL long-run coefficients. This condition is because the financial development and level of income coefficients were negative and statistically significant at a 1 percent level of significance.

Table 8: DOLS, FMOLS, and CCR Results

DV = CO_{2t}	DOLS		FMOLS		CCR	
Variables	**Coefficients**	**P-values**	**Coefficients**	**P-values**	**Coefficients**	**P-values**
Constant	3.831***	0.000	3.667***	0.000	3.666***	0.000
$lnFD_t$	-0.207**	0.019	-0.224***	0.000	-0.226***	0.000
$lnIC_t$	-0.498***	0.000	-0.470***	0.000	-0.470***	0.000
R^2& Adj-R^2	0.918 & 0.893		0.899 & 0.894		0.899 & 0.893	

Note: ** stands for the 5% level of significance, respectively

*** stands for the 1% level of significance, respectively

Source: Author Calculation

Granger Causality Test Result

The Testing of the direction of causality among CO_2 emissions, financial development, and income level was highly necessitated by the existence of a cointegration association between CO_2 emissions, financial development, and level of income, respectively, as shown by the bounds test result reported in Table 5. The result of the Granger causality test reported in Table 9 indicated that there exists bidirectional causality between financial development and CO_2 emissions. Another bidirectional causality is running from the level of income to CO_2 emissions. Similarly, there exists bidirectional causality running from financial development to level of income, respectively.

Table 9: Result of Granger Causality Test

Null Hypothesis	Obs.	F-Statistic	Direction of Causality
$lnFD_t$ does not granger cause $lnCO_{2t}$	37	3.743 (0.061) *	$lnFD_t \rightarrow lnCO_{2t}$
$lnICO_{2t}$ does not granger cause $lnFD_t$	37	3.459 (0.071) *	$lnCO_{2t} \leftarrow lnFD_t$
$lnIC_t$ does not granger cause $lnCO_{2t}$	37	7.622 (0.009) ***	$lnIC_t \rightarrow lnCO_{2t}$
$lnCO_{2t}$ does not granger cause $lnIC_t$	37	9.589 (0.003) ***	$lnCO_{2t} \leftarrow lnIC_t$
$lnFD_t$ does not granger cause $lnIC_t$	37	5.283 (0.027) **	$lnFD_t \rightarrow lnIC_t$
$lnIC_t$ does not granger cause $lnFD_t$	37	3.103 (0.087) *	$lnIC_t \leftarrow lnFD_t$

Note: *** stands for the 1% level of significance, respectively

** stands for the 5% level of significance, respectively

* stands for the 10% level of significance, respectively

Source: Author Calculation

Variance Decomposition and Impulse Response Results

This section focused on estimating the percentage change or variation in the dependent variable caused by the shock in the independent variables and one variable's response to shock in other variables. Test results are reported in Table 10 and Figure 4, respectively. The result from Table 10 showed that in period 1, CO_2 emissions response 100 percent to their shock or innovation. However, in period 5, the response percentage decreased to 87 percent approximately while financial development and level of income contributions were approximately 6 percent each. Toward the long-run in periods 9 and 10, own response decreases from 84 percent to 83 percent approximately. In contrast, the financial development response was approximately 6 percent for the two periods while that of the income level increases from 10 percent to 11 percent in periods 9 and 10.

Moreover, the financial development percentage response to its shock was 91 percent approximately, and CO_2 emissions contributed the remaining 9 percent. Again, in period 5, the own response decreases to 53 percent approximately where CO_2 emissions provide 37 percent and the level of income provide 10 percent approximately. In periods 9 and 10, the own response decreased where it accounted for 50 percent and 49 percent only. In comparison, CO_2 emissions and income level accounted for the constant approximated values of 35 percent and 15 percent for the two periods.

Similarly, the response of income level to shocks in CO_2 emissions and financial development was 98 percent, 87 percent, and 81 percent for the 1st, 5th, 9th and 10th periods, respectively. Simultaneously, CO_2 emissions are responsible for the 1 percent, 0.2 percent, 0.2 percent, and 0.3 percent, respectively, for the same periods. However, an approximated value of 1, 12, 19, and 19 percentage of the contributions were accounted for the financial development, especially 1st, 5th, 9th and 10th periods.

In summary, the analysis of variance decomposition revealed that apart from own shock response, level of income contributed more than the financial development to CO_2 emissions. However, when CO_2 emissions were the dependent variable, CO_2 emissions contributions were more significant than that of the income level when financial development was the dependent variable. Lastly, financial development contributed more than CO_2 emissions when the level of income was the explained variable.

Table 10: Variance Decomposition Analysis Result

Period	S.E.	$lnCO_{2t}$	$lnFD_t$	$lnIC_t$
Variance Decomposition of ln CO_{2t}				
1	0.069	100.000	0.000	0.000
5	0.124	87.903	5.744	6.352
9	0.141	83.784	6.039	10.175
10	0.143	82.850	6.477	10.671
Variance Decomposition of ln $F_{.D.A.}$				
1	0.168	9.258	90.741	0.000
5	0.282	37.026	52.837	10.135
9	0.297	34.821	50.097	15.081
10	0.301	34.620	49.968	15.411
Variance Decomposition of ln $I_{.C.T.}$				
1	0.036	1.426	0.197	98.376
5	0.115	0.223	12.421	87.354
9	0.181	0.172	18.543	81.284
10	0.194	0.310	18.593	81.096

Cholesky Ordering: $lnCO_{2t}$, $lnFD_t$, $lnIC_t$

Source: Author Calculation

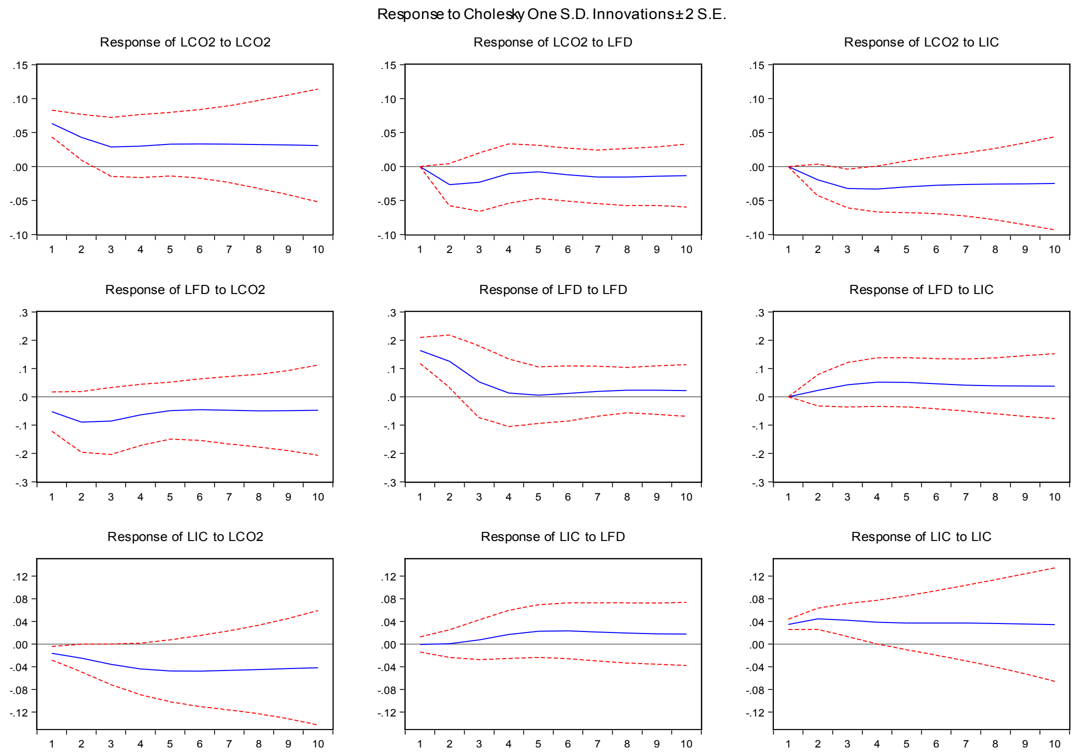


Figure 4: Impulse Response Analysis Result

Conclusion and Policy Recommendations

This paper investigated the effect of financial development on CO_2 emissions in Nigeria for the sample period of 1981 to 2018 using the ARDL approach analysis. The result of the unit root test from A.D.F. and P.P. revealed that all the series were stationary at the first difference, and therefore, they are all I(1) variables. In contrast, the Zivot-Andrew structural break test result showed a combination of two I(0) variables and one I(1) variable, respectively. These unit root test results guaranteed the ARDL bounds test application, and the result indicated a strong cointegration relationship among the series at a 1 percent level of significance.

The long-run and short-run ARDL results indicated that financial development and level of income have a negative and significant influence on the level of CO_2 emissions within the study period. The long-run ARDL estimates were subjected to some robustness checks using DOLS, FMOLS, and C.C.R., and their results conformed with that of the long-run ARDL coefficients. The ARDL analysis was subjected to some reliability tests, and their result indicated that the model is free and reliable for policymaking.

The Granger causality test results indicated bidirectional causality running from financial development to CO_2 emissions, level of income to CO_2 emissions, and financial development to level of income, respectively. The variance decomposition results indicated that shocks in financial development and income level contributed some quota to changes in the level of CO_2 emissions. The impulse response function result showed that a negative response was observed from financial development and income level due to shocks in CO_2 emissions.

Based on the above and the conclusion drawn from this paper's empirical findings, we recommended that there is a need for the expansion of the Nigerian financial market. This because in order to continue to supports financing clean environment alongside checking human income generation activities that bring about the emissions of CO_2 such as cutting down of trees in the forest for charcoal production, rapid and unnecessary bush burning, among others.

References

Ahmed, K., Shahbaz, M., Qasim, A., & Long, W. (2015). The linkages between deforestation, energy and growth for environmental degradation in Pakistan. *Ecological Indicators*, *49*, 95–103. https://doi.org/10.1016/j.ecolind.2014.09.040

Alrifai, K., Kalloub, M., & Musabeh, A. (2020). Financial development, economic growth and welfare: evidence from emerging countries. *Pressacademia*, *9*(2), 118–131. https://doi.org/10.17261/pressacademia.2020.1218

Ang, J. B. (2008). Economic development, pollutant emissions and energy consumption in Malaysia. *Journal of Policy Modeling*, *30*(2), 271–278. https://doi.org/10.1016/j.jpolmod.2007.04.010

Birdsall, N., & Wheeler, D. (1993). Trade Policy and Industrial Pollution in Latin America: Where Are the Pollution Havens? *The Journal of Environment & Development*, *2*(1), 137–149. https://doi.org/10.1177/107049659300200107

Bittencourt, M. (2012). Financial development and economic growth in Latin America: Is Schumpeter right? *Journal of Policy Modeling*, *34*(3), 341–355. https://doi.org/10.1016/j.jpolmod.2012.01.012

Çetin, M., & Ecevit, E. (2017). The impact of financial development on carbon emissions under the structural breaks: Empirical evidence from Turkish economy. *International Journal of Economic Perspectives*, *11*(1), 64–78.

Choong, C.-K., & Chan, S.-G. (2011). Financial development and economic growth: A review. *African Journal of Business Management*, *5*(6), 2017–2027.

Čižo, E., Lavrinenko, O., & Ignatjeva, S. (2020). Analysis of the relationship between financial development and economic growth in the EU countries. *Insights into Regional Development*, *2*(3), 645–660. https://doi.org/10.9770/ird.2020.2.3(3)

Claessens, S., & Feijen, E. (2006). Financial sector development and the millennium development goals. *World Bank Working Paper*. https://doi.org/10.2139/ssrn.950269

Crippa, M., Oregionni, G., Guizzard, D., Muntean, M., Schaaf, E., Lo Vullo, E., … Olivier, J. (2019). *Fossil CO2 and GHG emissions of all world countries*. *Journal of Geophysical Research: Atmospheres*. Retrieved from https://edgar.jrc.ec.europa.eu/overview.php?v=booklet2019

Dickey, D. A., & Fuller, W. A. (1981). Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root. *Econometrica*, *49*(4), 1057–1072. https://doi.org/10.2307/1912517

Durusu-Ciftci, D., Ispir, M. S., & Yetkiner, H. (2017). Financial development and economic growth: Some theory and more evidence. *Journal of Policy Modeling*, *39*(2), 290–306. https://doi.org/10.1016/j.jpolmod.2016.08.001

Epule, T. E., Peng, C., & Lepage, L. (2015). Environmental refugees in sub-Saharan Africa: a review of perspectives on the trends, causes, challenges and way forward. *GeoJournal*. https://doi.org/10.1007/s10708-014-9528-z

Frankel, J. A., & Romer, D. (1999). Does trade cause growth? *American Economic Review*, *89*(3), 379–399. https://doi.org/10.1257/aer.89.3.379

Granger, C. W. J. (1969). Investigating Causal Relations by Econometric Models and Cross-spectral Methods. *Econometrica*, *37*(3), 424. https://doi.org/10.2307/1912791

Halicioglu, F. (2009). An econometric study of CO2 emissions, energy consumption, income and foreign trade in Turkey. *Energy Policy*, *37*(3), 1156–1164. https://doi.org/10.1016/j.enpol.2008.11.012

Jalil, A., & Feridun, M. (2011). The impact of growth, energy and financial development on the environment in China: A cointegration analysis. *Energy Economics*, *33*(2), 284–291. https://doi.org/10.1016/j.eneco.2010.10.003

Janpolat, K., Odilova, S., Nodira, A., Salahodjaev, R., & Khachaturov, A. (2021). Financial development and energy consumption nexus in 32 belt and road economies. *International Journal of Energy Economics and Policy*, *11*(2), 368–373. https://doi.org/10.32479/ijeep.10862

Kazar, A., & Kazar, G. (2016). Globalization, financial development and economic growth. *International Journal of Economics and Financial Issues*, *6*(2), 578–587.

Lenka, S. K. (2015). Measuring financial development in India: A PCA approach. *Theoretical and Applied Economics*, *XXII*(1), 205–216.

Lenka, S. K., & Sharma, R. (2017). Does Financial Inclusion Spur Economic Growth in India? *The Journal of Developing Areas*, *51*(3), 215–228. https://doi.org/10.1353/jda.2017.0069

Ma, X., & Fu, Q. (2020). The influence of financial development on energy consumption: Worldwide evidence. *International Journal of Environmental Research and Public Health*, *17*(4). https://doi.org/10.3390/ijerph17041428

Mahmood, H. (2020). Impact of financial market development on the co2 emissions in GCC countries. *Accounting*, *6*(5), 649–656. https://doi.org/10.5267/j.ac.2020.6.020

Mahmood, H., Alrasheed, A. S., & Furqan, M. (2018). Financial market development and pollution nexus in Saudi Arabia: Asymmetrical analysis. *Energies*, *11*(12). https://doi.org/10.3390/en11123462

Mahmood, H., Furqan, M., & Bagais, O. A. (2019). Environmental accounting of financial development and foreign investment: Spatial analyses of East Asia. *Sustainability (Switzerland)*, *11*(1). https://doi.org/10.3390/su11010013

Maijama'a, R., & Musa, K. S. (2020). Crude Oil Price, Urbanization and Environmental Pollution in Nigeria: Evidence from ARDL Approach. *Asian Journal of Economic Modelling*, *8*(4), 227–240. https://doi.org/10.18488/journal.8.2020.84.227.240

Mercan, M., & Gocar, İ. (2013). The Effect of Financial Development on Economic Growth in BRIC-T Countries: Panel Data Analysis. *Journal of Economic and Social Studies*, *3*(1), 199–218. https://doi.org/10.14706/jecoss11318

Musa, K. S., Maijama'a, R., Shaibu, H. U., & Muhammad, A. (2019). Crude Oil Price and Exchange Rate on Economic Growth: ARDL Approach. *OALib*, *6*(12), 1–5. https://doi.org/10.4236/oalib.1105930

Okoye, L. U., Omankhanlen, A. E., Okoh I, J., Ezeji, F. N., Ehikioya I, B., & Okoye, H. C. (2019). Examining Economic Growth Drivers in Nigeria. In *Vision 2025: Education Excellence And Management Of Innovations Through Sustainable Economic Competitive Advantage* (pp. 13295–13302).

Omri, A., Daly, S., Rault, C., & Chaibi, A. (2015). Financial development, environmental quality, trade and economic growth: What causes what in MENA countries. *Energy Economics*, *48*, 242–252. https://doi.org/10.1016/j.eneco.2015.01.008

Orji, A., Ogbuabor, J. E., Nwosu, E., Anthony-Orji, O. I., & Isaac, S. T. (2019). Financial development, human capital and economic growth In Nigeria: An empirical analysis. *Journal of Academic Research in Economics*, *11*(3), 507–531.

Pesaran, M. H., Shin, Y., & Smith, R. J. (2001). Bounds testing approaches to the analysis of level relationships. *Journal of Applied Econometrics*, *16*(3), 289–326. https://doi.org/10.1002/jae.616

Phillips, P. C. B., & Perron, P. (1988). Testing for a unit root in time series regression. *Biometrika*, *75*(2), 335–346. https://doi.org/10.1093/biomet/75.2.335

Rosalia, M.-R. G. (2013). Impact of Financial Development on Economic growth: Evidence from Latin America.

Shahbaz, M., Kumar Tiwari, A., & Nasir, M. (2013). The effects of financial development, economic growth, coal consumption and trade openness on CO2 emissions in South Africa. *Energy Policy*, *61*, 1452–1459. https://doi.org/10.1016/j.enpol.2013.07.006

Shahbaz, M., & Lean, H. H. (2012). Does financial development increase energy consumption? The role of industrialization and urbanization in Tunisia. *Energy Policy*, *40*(1), 473–479. https://doi.org/10.1016/j.enpol.2011.10.050

Shahbaz, M., Solarin, S. A., Mahmood, H., & Arouri, M. (2013). Does financial development reduce CO2 emissions in Malaysian economy? A time series analysis. *Economic Modelling*, *35*, 145–152. https://doi.org/10.1016/j.econmod.2013.06.037

Shahzad, S. J. H., Rehman, M. U., Hurr, M., & Zakaria, M. (2014). *Do Economic and Financial Development Increase Carbon Emission in Pakistan: Empirical Analysis through ARDL Cointegration and VECM Causality*. *Munich Personal RePEc Archive*.

Sulaiman, C. (2014). Financial Development and Inflation Nexus in Nigeria: Evidence from ARDL Bounds Testing. *Research Journal of Finance and Accounting*, *5*(10), 50–56.

Sulaiman, C., & Abdul-Rahim, A. S. (2018). Population Growth and CO2 Emission in Nigeria: A Recursive ARDL Approach. *SAGE Open*, *8*(2). https://doi.org/10.1177/2158244018765916

Tamazian, A., Chousa, J. P., & Vadlamannati, K. C. (2009). Does higher economic and financial development lead to environmental degradation: Evidence from BRIC countries. *Energy Policy*, *37*(1), 246–253. https://doi.org/10.1016/j.enpol.2008.08.025

The World Bank. (2020). *WORLD DEVELOPMENT INDICATORS*. Retrieved from https://datatopics.worldbank.org/world-development-indicators/

Valickova, P., Havranek, T., & Horvath, R. (2015). Financial development and economic growth: A meta-analysis. *Journal of Economic Surveys*, *29*(3), 506–526. https://doi.org/10.1111/joes.12068

Xiang, L., & Dongye, Y. (2016). Research on the Relationship between Financial Development and Economic Growth : Based on an Empirical Analysis of Shenzhen. *Journal of Applied Finance & Banking*, *6*(4), 17–26.

Zhang, Y. J. (2011). The impact of financial development on carbon emissions: An empirical analysis in China. *Energy Policy*, *39*(4), 2197–2203. https://doi.org/10.1016/j.enpol.2011.02.026

Zivot, E., & Andrews, D. W. K. (1992). Further evidence on the great crash, the oil-price shock, and the unit-root hypothesis. *Journal of Business and Economic Statistics*, *10*(3), 251–270. https://doi.org/10.1080/07350015.1992.10509904

APPENDIX

Dependent Variable: LCO2
Method: ARDL
Date: 09/22/20 Time: 15:54
Sample (adjusted): 1983 2018
Included observations: 36 after adjustments
Maximum dependent lags: 2 (Automatic selection)
Model selection method: Akaike info criterion (A.I.C.)
Dynamic regressors (3 lags, automatic): LFD LIC
Fixed regressors: C
Number of models evaluated: 32
Selected Model: ARDL(2, 0, 0)
Note: final equation sample is more significant than selection sample

Variable	Coefficient	Std. Error	t-Statistic	Prob.*
LCO2(-1)	0.331784	0.162763	2.038452	0.0501
LCO2(-2)	-0.240166	0.142813	-1.681675	0.1027
L.F.D.	-0.136437	0.047769	-2.856166	0.0076
LIC	-0.502403	0.118981	-4.222553	0.0002
C	3.738267	0.833584	4.484571	0.0001

R-squared	0.925407	Mean dependent var	-0.330961
Adj R-squared	0.915782	S.D. dependent var	0.190134
S.E. of regression	0.055178	Akaike info criterion	-2.828275
Sum squared resid	0.094381	Schwarz criterion	-2.608342
Log-likelihood	55.90895	Hannan-Quinn criter.	-2.751512
F-statistic	96.14709	Durbin-Watson stat	2.132852
Prob(F-statistic)	0.000000		

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

ARDL Bounds Test
Date: 09/22/20 Time: 15:55
Sample: 1983 2018
Included observations: 36
Null Hypothesis: No long-run relationships exist

Test Statistic	Value	K
F-statistic	6.143625	2

Critical Value Bounds

Significance	I0 Bound	I1 Bound
10%	3.17	4.14
5%	3.79	4.85
2.5%	4.41	5.52
1%	5.15	6.36

ARDL Cointegrating And Long Run Form
Dependent Variable: LCO2
Selected Model: ARDL(2, 0, 0)
Date: 09/22/20   Time: 15:53
Sample: 1981 2018
Included observations: 36

Cointegrating Form

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(LCO2(-1))	0.240166	0.142813	1.681675	0.1027
D(LFD)	-0.136437	0.047769	-2.856166	0.0076
D(L.I.C.)	-0.502403	0.118981	-4.222553	0.0002
CointEq(-1)	-0.908382	0.164613	-5.518291	0.0000

Cointeq = LCO2 - (-0.1502*LFD -0.5531*LIC + 4.1153)

Long Run Coefficients

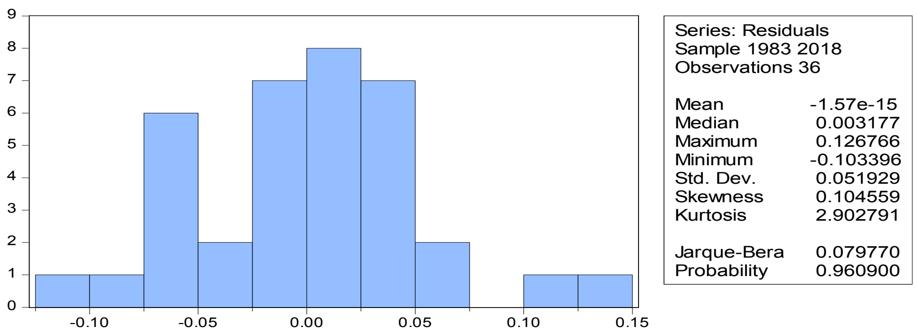
Variable	Coefficient	Std. Error	t-Statistic	Prob.
L.F.D.	-0.150198	0.050342	-2.983523	0.0055
LIC	-0.553074	0.071871	-7.695343	0.0000
C	4.115303	0.451761	9.109471	0.0000

Breusch-Godfrey Serial Correlation L.M. Test:

F-statistic	1.179218	Prob. F(2,29)	0.3218
Obs*R-squared	2.707524	Prob. Chi-Square(2)	0.2583

Heteroskedasticity Test: Breusch-Pagan-Godfrey

F-statistic	0.942778	Prob. F(4,31)	0.4524
Obs*R-squared	3.904393	Prob. Chi-Square(4)	0.4191
Scaled explained SS	2.754439	Prob. Chi-Square(4)	0.5997



Musaey RESET Test
Equation: UNTITLED
Specification: LCO2 LCO2(-1) LCO2(-2) LFD LIC C
Omitted Variables: Squares of fitted values

	Value	df	Probability
t-statistic	0.895442	30	0.3777
F-statistic	0.801817	(1, 30)	0.3777

F-test summary:

	Sum of Sq.	df	Mean Squares
Test SSR	0.002457	1	0.002457
Restricted SSR	0.094381	31	0.003045
Unrestricted SSR	0.091925	30	0.003064