Foreign Direct Investment, Environmental Pollution and Life Expectancy in Nigeria

Abubakar Saad Bahuli, Innocent Okwanya, Toryila Raphael Orshio

Department of Economics, Faculty of Social Sciences, Federal University Lafia, Nasarawa State, Nigeria

Abstract

This study examines the effect of foreign direct investment and environmental pollution on life expectancy in Nigeria. Using annual time series data on Carbon Emission (CO_2), Life Expectancy (LEX), Economic Growth (GDP per capita), Population Growth rate (POP), and Foreign Direct Investment (FDI) were sourced from the World Bank online Database 2023. The study employed the Autoregressive Distributed Lag (ARDL) approach. The results reveal that carbon emission (CO_2) has negative effects on life expectancy in the long run and short run coefficients. Furthermore, the result of the Error Correction Mechanism (ECM) explored the speeds of adjustment from long-run to short-run equilibrium is very low 7.4 percent per annum. The findings of this study recommend the following policies that will improve the environmental quality and life expectancy. The effect of environmental pollution can be reduced if the government adopts an effective fiscal measure on fossils/carbon emissions in both public and private enterprises. Also, governments and industries should invest in sources of clean energy that will improve the ecological friendly for sustainable development.

Keywords

Carbon Emission, Life Expectancy, Population Growth, Foreign Direct Investment

1. Introduction

Carbon Emissions jeopardize life expectancy, through environmental pollution from fossil fuels which reduces the life expectancy of people by 2-3 years. In addition, millions of people lost their lives because of carbon emissions. According to a World Health Organization report, (2022) about eight million lives are lost globally every year. The decline of individuals' lifespans due to environmental pollution raises the attention of researchers and policy makers worldwide to examine the ways of mitigating environmental pollution (CO2) to improve the livelihood of individuals taking life expectancy as the health indicator [1].

Furthermore, the effects of environmental pollution on life expectancy are rapidly increasing developing countries particularly sub-Saharan Africans to the extends that within a single decade the lifespan declined by 5 years from 57 to 52 (World Bank Report, 2022). In most of the developing countries foreign direct investment (FDI) inflows contributes a lot in releasing the emissions that destroy ozone layers and harm the health status. In Nigeria, environmental havoc is among the principal variables that has direct effect on health outcomes such as infant mortality rate and life expectancy. In year 2019 the life expectancy at birth was 52. 9 years then 2022 was 52.6 years within the couples of three years the lifespan drastically declined by 0.3 percent. While the environmental pollution results by carbon emission was increased by 11.5 percent per annum from 2019 to 2022. Then the inflows of foreign direct investment (FDI) were increasing by 7.5 percent each year. Therefore, the increase of FDI inflows has positive effect on economic growth but negative effect on human lifespan [2].

However, many policies and rules has been adapted by the government agencies and nongovernmental organizations such as Millennium Development Goals (MDGs) from year 2000 and changed to Sustainable Development Goals (SDGs) in 2010, Environmental Safety Regularization, Environmental Standard and Regulations Enforcement Agency (NASEREA) and so forth. All with similar goals and objectives of attaining or ensuring clean and healthier environment for the benefits of citizen and world at large as designed and signed by Kyoto Protocol agreement of 1997. Thus, with the efforts of government agencies, nongovernmental organizations and World Banks, the issues of carbon emission are still a bottleneck both environmental quality and health outcomes in Nigeria [3]. Therefore, the aim of this paper is to examine the effect of carbon emission on life expectancy in Nigeria. The structures of this study are divided into five sections apart from this introduction, the remaining four sections are; literatures reviews, methodology, results and discussion and finally conclusion and recommendations.

2. Litritures Review

Few studies have looked into how carbon emissions and life expectancy affect each other around the world and in specific countries. Majid et al. (2023) looked at how environmental factors influence health in Pakistan using time series data on deforestation, temperature, carbon emissions, and life expectancy. Their study used the Autoregressive

Distributive Lag (ARDL) method and found a long-term connection between environmental factors and life expectancy. They also found that more rainfall and higher levels of urbanization are linked to longer life expectancy in Pakistan. Similarly, Rahmadi and Rusgianto (2023) studied energy use and carbon emissions in Indonesia using annual data on energy consumption, CO2 emissions, economic growth, and the human development index. Their analysis with the Vector Error Correction Model and Granger causality test showed a long-term effect and a one-way cause-and-effect relationship between carbon emissions and the human development index in Indonesia [4].

In Indonesia, Karma (2023) looked at the socioeconomic factors that affect life expectancy in Southeast European countries. They used a two-panel regression with a fixed effect model. The findings showed that spending on healthcare has a positive effect on life expectancy, and the most important factors influencing this were carbon emissions and fertility rates. Nica et al. (2023) studied how financial development, health spending, carbon emissions, institutional quality, and the use of mixed energy sources impact life expectancy in Eastern Europe. They used the Cross-Sectional Autoregressive Distributive Lag Model (CS-ARDL). Their results showed that higher health spending and the use of clean, renewable energy improve health outcomes in Eastern European countries. Atik et al. (2023) looked at the green economy and sustainable development, focusing on the role of social and environmental indicators [5]. They used time series data along with Autoregressive Distributive Lag (ARDL) techniques. Their results showed a long-term, positive relationship between the green economy and sustainable development.

Furthermore, Tru (2019) looked into how economic growth, energy use, and carbon emissions are connected in Central Asia. They used panel regression analysis and found that economic growth is linked to carbon emissions. There's also a one-way relationship between carbon emissions and economic growth in Central Asian countries. Murthy, Shaari, Anthony, and Zainol (2021) studied the connections between carbon emissions, economic growth, and life expectancy in some developing countries across different continents using panel Autoregressive Distributive Lag (ARDL) methods. Their results showed that carbon emissions have a negative impact on both economic growth and life expectancy in these countries [6]. Similarly, Amjad and Audi (2016) looked at how income inequality, environmental damage, and globalization affect life expectancy. Using ARDL techniques, they found that income inequality and environmental degradation both have negative effects on life expectancy. Garidzirai (2020) did a time series analysis on carbon emissions, population, carbon tax, and energy use in South Africa using the Autoregressive Distributive Lag (ARDL) model. The results showed that population has a positive effect on carbon emissions, while carbon tax helps reduce emissions in South Africa. Abubakar and Tasiu et al. (2022) examined the relationship between carbon dioxide emissions and economic growth in Nigeria, looking at the role of financial development. They used ARDL methods and found that carbon emissions have a negative effect on economic growth [7]. They also found a long-term relationship between economic growth and financial development in Nigeria.

Similarly, Amjad and Ahmad (2014) examined how socioeconomic factors affect life expectancy in Oman. Using the ARDL method, their results showed that inflation, population growth, and per capita income affect carbon emissions in the short term and negatively impact life expectancy in Oman. Agbanike et al. (2019) examined the relationship between oil, environmental pollution, and life expectancy in Nigeria. Using ARDL techniques, they found that environmental pollution leads to high carbon emissions, which in the long term affects life expectancy [8]. Similarly, Amuka et al. (2018) analyzed the impact of climate change on life expectancy in developing countries, focusing on greenhouse gas (CO2) emissions in Nigeria. Using time series data and OLS regression analysis, they found that carbon emissions had no significant effect on life expectancy. In Pakistan (2022), Azam, Uddim, and Saqib examined factors influencing life expectancy and environmental degradation. Using time series and ARDL techniques, they found that public health spending and education have a positive impact on life expectancy, while population growth and carbon emissions have a negative impact [9]. Osabohein et al. (2020) used the ARDL method to examine the impact of carbon emissions on life expectancy in Nigeria and found a negative impact. Rjoub et al. (2021) explored the causal relationship between carbon emissions, economic growth, and life expectancy in Turkey. Using the Toda-Yamamoto causality technique, they found a unidirectional causal relationship between carbon emissions and economic growth. They also found a bidirectional causal relationship between economic growth and life expectancy. In the domestic and international literature reviewed in this article, no study used carbon emissions as a moderator to examine the impact of foreign direct investment on life expectancy. This explains the relationship between foreign direct investment and health outcomes (measured by life expectancy at birth in Nigeria).

3. Methodology

This paper is an ex-post research study that used time series data for empirical analysis from 1990 to 2022. The data on carbon emissions (CO2), life expectancy (LEX), economic growth (GDP per capita), population growth rate (POP), and foreign direct investment inflow (FDI) were obtained from the World Bank online database in 2023. The study is based on the Kuznets Environmental Curve (KEC) hypothesis from 1955 and Grossman's (2000) Human Capital Model, which suggests that as income levels (measured by GDP per capita) increase, carbon emissions (CO2) tend to decrease, and health outcomes improve.

$CO_2 = f\,(GDPP)$ (1)

Where, CO_2= Carbon emission or environmental pollution and

GDPP = Gross Domestic Product Per capita.

3.1 Models Specification

Equation 2 is the modified functional model to investigate the effect of carbon emission on life expectancy to see if the potential of carbon emission (CO_2) influences on economic growth (GDP per capita) as a mediating variable in the model [10].

$LEX=f(CO_2, GDP, POP, FDI)$ (2)

Where:

LEX = Life Expectancy, CO_2 = Carbon Emission, GDP = Gross Domestic Product per capita, FDI = Foreign Direct Investment. Thus, the Econometric model of equation (2) is specified in equation (3) below.

$LEX_t = \beta_0+\beta_1CO2_t+\beta_2GDP_t+\beta_3POP_t+\beta_4FDI_t+\varepsilon_t$ (3)

β_0 is an intercept then β_1,β_2,β_3, and β_4 are coefficients of independent variables then ε is the stochastic variable while t is the time series. Furthermore, equation 3 enables this paper to analyze ∂∂the effect of carbon emission (CO_2) on life expectancy (LEX) varies with the level of economic growth (GDP per capita).

$$\frac{\partial(LEX)t}{\partial(CO2)t}=\beta 1+\beta_3 GDPt \quad (4)$$

A positive and significant coefficient of the marginal effect of β_1+ β_3GDP_t denotes that an increase of economic growth (GDP) per capita improves the life expectancy (LEX) and adverse selection effect of carbon emission (CO_2) on life expectancy (Murthy et al., 2021, Magit et al., 2023, Karma, 2023)

3.2 Unit Root Model

The study used the Augmented Dickey-Fuller (ADF) unit root test to examine if the variables were stationary, applying a t-statistic based on the regression model as outlined by Kwaitkwoski, Phillips, Schmidt, and Shin in 1992.

$\Delta y_t = \alpha + py_{t-1} + \theta_1\Delta y_{t-1}...+\theta_k\Delta y_{t-k}+\mu_t$ (5)

Where;

y_t = Series

μ_t = Error Terms

The equation used the null hypothesis to test the stationary:

H_o: P = 0 (unit root)

H_1: P < 0 (series is stationary)

The t-statistic is likely to be negative and significant at the 1%, 5%, and 10% levels according to the results from Equation 5. Therefore, if the variable is stationary, the null hypothesis should be rejected, and if it's not stationary, the null hypothesis would not be rejected.

3.3 Autoregressive Distributive Lag (ARDL) Bound Test/Cointegration Model

This study adopts the Autoregressive Distributive Lag (ARDL) Bound model to investigate the long-run relationships (cointegration) between Life Expectancy (LEX) and Carbon Emission (CO_2) using a critical bound test approach developed by Pesaran, Shin, and Smith (2021) as shown in equation (5):

$$LEX_t=\beta_0+\beta_2LEX_{t-1}+\beta_3CO2_{t-1}+\beta_4GDP_{t-1}+\beta_5POP_{t-1}+\beta_6FDI_{t-1}$$

$$+\sum_{i=1}^{P}\alpha 1\Delta LEXt-1+\sum_{i=1}^{P}\alpha 2\Delta CO2t-1+\sum_{i=1}^{P}\alpha 3\Delta GDPt-1+\sum_{i=1}^{P}\alpha 4\Delta POPt-1+\sum_{i=1}^{P}\alpha 1\Delta FDIt-1+\varepsilon t \quad (6)$$

To test Equation 5, you can examine the null hypothesis against the alternative hypothesis.

H_o: $\beta_1=\beta_2=\beta_3=\beta_4=\beta_5=\beta_6=0$, and

H_1: $\beta_1\neq\beta_2\neq\beta_3=\beta_4\neq\beta_5\neq\beta_6\neq 0$

The acceptance and rejection of null and alternative hypotheses can be determined by the values F-statistic and upper bound (1) in each case [11]. If F-statistic is greater than the upper bound at 1%, 5% or 10% the null hypothesis should be rejected and the alternative hypothesis, meaning that is the long-run relationship (cointegration) between endogenous and exogenous variables and vice-versa.

After confirming the existence of a long-run relationship (cointegration) between the dependent and independent variables in the model, the long-run, and short-run effects, and speed of adjustment (Error Corrections) were analyzed using equations 7 and 8 respectively.

$LEX_t=\beta_0+\beta_2LEX_{t-1}+\beta_3CO_{2t-1}+\beta_4GDP_{t-1}+\beta_5POP_{t-1}+\beta_6FDI_{t-1}+ \varepsilon t$ (7)

Furthermore, from the evidence of the existence of long-run relationship effects between dependent and independent variables. The coefficients of the short run can be estimated using the Error Correction Mechanism (ECM) Model in Equation (8).

$\Delta LEX_t=$

$$\alpha_0 + \sum_{i=1}^{P} \alpha 1 \Delta LEXt - 1 + \sum_{i=1}^{P} \alpha 2 \Delta CO2t - 1 + \sum_{i=1}^{P} \alpha 3 \Delta GDPt - 1 + \sum_{i=1}^{P} \alpha 4 \Delta POPt - 1 + \sum_{i=1}^{P} \alpha 1 \Delta FDIt - 1 + \beta 1 ECMt - 1 + \varepsilon t \quad (8)$$

$ECMt_{-1}$ is an error correction mechanism that measures the speeds of disequilibrium from the long run to the short run, while t-1 is the lagged period of one year the β_1 is the coefficient of the speeds of adjustment respectively.

3.4 Diagnostics Test

Some of the post-estimation tests conducted are the Breusch-Godfrey (BG) correlation test, the Breusch-Pegan-Godfrey (BPG) Heteroskedasticity test and the Jarque-Bera (JB) Normality test all are checks the robustness of the model.

4. Results and Discussions

It is paramount in very econometric time series research to conduct a descriptive statistics analysis to know the behaviors of the variables in the model as shown in the table below:

Table 1. Descriptive Statistics Results

	CO2	FDI	GDP	LEX	POP
Mean	0.181679	1.575907	1.611471	49.25233	2.597366
Median	0.150776	1.450318	1.596033	49.73000	2.574829
Maximum	0.307083	5.790847	12.27614	52.91000	2.764062
Minimum	0.106304	-0.039128	-4.507149	45.48700	2.380007
Std. Dev.	0.072326	1.215174	3.790370	2.749484	0.106715
Observations	33	33	33	33	33

Source: *Author's Computations Using E-views 13, 2023.*

Table 1 list the summary of statistical behaviors of the variables, the average value of carbon emission is 0.181, the middle value is 0.150, the maximum is 0.30, the minimum value is 0.10 and the standard deviation is 0.072 which reveals that the carbon emission (CO_2) not widely distributed along the mean per annum throughout the study [12]. Likewise, for the foreign direct investment (FDI), the average value is 1.57, the middle value is 1.45, the highest value is 5.79, the minimum value is -0.03 and the standard deviation is 1.21 showing very slow variations along the average values. Similarly, the statistical summary of economic growth (GDP) shows the mean value is 1.61, the middle value is 1.59, the highest value is 12.9, the minimum is negative -4.50 and the variation between mean is very widely 3.79. However, in the summary of life expectancy (LEX) explored the mean is 49.25, the median is 49.73, the highest value is 52.91, the minimum is 45.48 and the standard deviation is along the average value is very low 2.74. Finally, the summary of the population growth rate (POP) shows the average value is 2.59, a middle value of 2.57, a maximum of 2.76, a minimum of 2.38, and the standard deviation is 0.10 which is a low variation along the average value per annum throughout the study [13].

Table 2. Augmented Dickey Fuller (ADF) Unit Root Results

Variables	Level	First Difference	Stationary Status
LEX	-2.957110	-2.960411**	I(1)
CO2	-2.976263	-2.960411**	I(1)
GDP	-2.957110 *	---------	I(0)
POP	-2.976263	-2.627420**	I(1)
FDI	-2.960411	-2.619160**	I(1)

Note: * Indicate Stationary at Level, ** Indicate Stationary at First Different

Author's Computations Using E-views 13, 2023.

Table 2 explain the result of Augmented Dickey Fuller Unit Root (ADF) test in table two shows that all consonants in the model Life Expectancy (LEX), Carbon Emission (CO_2), Population Growth Rate (POP) and Foreign Direct

Investment (FDI) are stationary at first difference I(1) with exception of Economic Growth (GDP) that is stationary at level I(0). The Autoregressive Distributive Lag (ARDL) were employed in this paper due to the mixed integrations of the series [14].

Table 3. Bound Test Result

LEX=f (CO2, GDP, POP, FDI)			**F-statistic 10.168562**			
	10%		**5%**		**1%**	
Sample Size	I(0)	I(1)	I(0)	I(1)	I(0)	I(1)
33	2.525	3.560	3.058	4.223	4.280	5.840
	2.200	3.090	2.560	3.490	3.290	4.370

Author's Computations Using E-views 13, 2023.

Table 3 list the result of the ARDL-Bound test reveals the existence long run (cointegration) between the variables life expectancy (LEX), carbon emission (CO_2), economic growth (GDP), and foreign direct investment (FDI) with evidence of F-statistic 10.168562 greater than both lower I(0) and upper I(1) bounds at 1% I(0) 4.280, I(1) 5.840, then at 5% I(3.058), I(1) 4.223 and at 10% I(0) 2.525, I(1) 3.560 respectively [15]. Thus, the next stages are to analyze the long-run, and short-run effects then the Error Correction Mechanism (ECM) to analyze the speeds of adjustment (disequilibrium) to restore the short-run equilibrium.

Table 4. ARDL Long Run and Short Run Effect Results

Dependent Variable: LEX				
Variable	**Coefficient**	**Std. Error**	**t-Statistic**	**Prob.***
ARDL Long Run				
CO2	-2.185889	2.354571	-0.928360	0.3629
FDI	-0.070688	0.036383	-1.942869	0.0644
GDP	-1.19E-05	0.012021	-0.000989	0.9992
POP	5.085600	1.109633	4.583137	0.0001
ARDL Short Run				
D(CO2(-1)	-2.742414	1.263939	-2.169735	0.0437
D(FDI(-1)	0.066044	0.025809	2.558948	0.0197
GDP(-1)	0.000798	0.011254	0.070944	0.9441
sD(POP(-1)	-2.088495	1.188696	-1.756963	0.0959
ECM*	-0.073950	0.008046	-9.191152	0.0000

Author's Computations Using E-views 13, 2023.

Table 4 show the results of were divided into two sections, the first section is the coefficients of the long-run effects between life expectancy (LEX), carbon emission (CO_2), foreign direct investment (FDI), economic growth (GDP), and population growth rate (POP) in Nigeria. The outcomes show that carbon emission (CO_2) has negative effects on life expectancy in both long-run and short-run equilibrium. This means that a 1 percent increase in carbon emission will lead to a 2.19 decrease in life expectancy in the long run. Similarly, a 1 percent increase in carbon emission will result in a 2.74 percent decrease in life expectancy in the short run. This outcome is consistent with the findings of the previous studies [16].

However, foreign direct investment (FDI) and economic growth (GDP) have negative effects on life expectancy (LEX) in both a long-run and short-run equilibrium. This finding is in line with the past results (see Tru, 2019 & Tasiu et al., 2019). While population growth rate (POP) has an effect on life expectancy (LEX) in the short-run equilibrium [17]. Meaning that an increase in population by 1 percent will result from a decline in life expectancy by 2.08 percent respectively. Thus, the Error Correction Mechanism (ECM) coefficient shows the speed of adjustment for the effect of carbon emission (CO_2) on life expectancy (LEX) to restore to short-run equilibrium in Nigeria is 7 percent per annum [18].

Table 5. ARDL Diagnostics Test Results

Test	F-statistic
serial correlation	
Breusch-Godfrey	1.415232 (0.2838)
Heteroskedasticity	
Breusch-Pagan-Godfrey	0.907470 (0.5757)
Normality	
Jarque-Bera	0.496573(0.780136)

Author's Computations Using E-views 13, 2023.

Table 5 mention the post-estimation tests used Breusch-Godfrey (BG) for serial correlation, Breusch-Pagan-Godfrey (BPG) for heteroskedasticity, and Jarque-Bera (JB) for normality to check if the model is reliable and works well [19]. The results show that there is no serial correlation or heteroskedasticity in the model, as the F-statistic values of 1.41 and 0.90 are higher than the p-values of 0.28 and 0.57, respectively. Also, the Jarque-Bera (JB) test shows the residuals are normally distributed, with a p-value of 0.78, which is higher than 5 percent [20].

5. Conclusion and Recommendations

The purpose of this study is to examine the effect of carbon emission (CO_2) on life expectancy (LEX) in Nigeria. The results of empirical analysis using the Autoregressive Distributive Lag (ARDL) approach show the long-run equilibrium between carbon emission (CO_2) and life expectancy (LEX) in Nigeria. Also, both long and short-run coefficients reveal that carbon emission (CO_2) has a negative effect on life expectancy (LEX). However, in the short run increase in foreign direct investment (FDI) inflow and economic growth (GDP) has a direct relationship with an increase in carbon emission (CO_2) and consequently affects the life expectancy in Nigeria.

Based on the outcomes of empirical analysis, this study concludes that an increase in foreign direct investment (FDI) inflow such as multinational corporations /industries boost economic growth (GDP) and leads to high pollution that is carbon emission (CO_2). However, there is a certain stage of economic growth that will be regarded as a turning point of carbon emission based on the ARDL-Error Correction Mechanism outcome of this study that is in line with the results of Ram, (1991) and Melikhova et al. (2014).

Finally, based on the findings this study recommends the following policies that will reduce the carbon emission to improve life expectancy. The effect of carbon emissions can be reduced if governments and agencies adopt an effective strategy that will reduce fossil emissions. Also, governments and industries should invest in sources of clean energy that will improve the ecological friendly for sustainable development.

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