Innovations

Impact of Financial Development and Demographic Change on Carbon Emission in Nigeria

Omede Samson Opaluwa
Student, The Department of Banking and Finance, University of Nigeria, Enugu State, Nigeria

Abstract: *This study explores financial development and demographic changes and its impact on carbon emissions in Nigeria. The study adopted the use of time series data and employed the Augmented Dickey Fuller (ADF) unit root test and the Johnsen co-integration test to determine the data's stationarity and long-run co-integration relationship. The study further utilized a vector error correction model (VECM) to analyze and evaluate the short-run and long-run relationships between the model's variables. The result shows that financial development indicators, logcpi, logfdi and loggdp, all exhibits negative relationship with carbon emissions at 5% significance (P-value< 005) and demographic factors, logpd and logpgr, show a positive impact on carbon emissions in the long run at P<0.05. All short-run estimates of the model are statistically non-significant at 5% (p-value > 0.05). The study concludes that financial development has a negative impact on carbon emissions, while demographic changes increase carbon emissions in the long run. The study recommends that the promotion of programs that mitigate carbon emission should be encouraged by financial institutions in Nigeria and as increased population growth rate and population density have a mitigating effect on the quality of the environment in the long run, there should be increased advocacy and environmental awareness to engage all stakeholders in efforts to address climate change and reduce carbon emissions.*

Keywords: *Carbon, Emission, Financial Development, Nigeria, Demographic Change.*

1 Introduction

1.1 Introduction of the Research Problem

Environmental issues are now widely acknowledged as a significant risk to human health. The topic of carbon emissions, has been considered as a major contributor to human-induced global warming, this remains highly debated and contested (Fallahi,

2020). The term "environmental quality" has gained popularity due to the increased focus on sustainable development.
This study aims to explore the environmental implications of emissions utilizing concepts like carbon emission accounting, financial development, and population control measures to reduce the risk to Nigeria's sustainable development posed by carbon emissions, both in the short and long-term. Financial development plays a crucial role in influencing carbon emissions, and the exclusion of this variable from carbon emission models could lead to biased and inaccurate empirical outcomes (Hao et al., 2016; Shahbad et al., 2016).

CO2 emissions are primarily associated with human activities, leading to an upsurge in emissions. These activities encompass the burning of fossil fuels, deforestation, land use alterations, livestock practices, and fertilization, resulting in a net rise in emissions (IPCC, 2012).This study therefore intends to offer tentative answers to two questions, which are:

i. To what extent has financial development impacted carbon emission intensity in Nigeria?

ii. To what extent do demographic changes impact carbon emissions?

Examining these research questions will serve as the basic theoretical foundation for this study. All together, these questions are an important recipe for understanding how financial development in Nigeria impacts carbon emissions and how demographic changes also impact carbon emissions.

In the extant literature, little or no consideration has been given to understudy the impact of financial development and demographic changes on carbon emission in Nigeria, as the impact of each independent variable (financial development or demographic changes) are studied independently and separately on carbon emission. Studies that focuses on financial development impact on carbon emissions includes; (Zakari et al., 2022; 2022;Jakada et al., 2020; Ali et al., 2019; Alege et al., 2017; AbbasiandRiaz, 2016; Javidand Sharif, 2016). While studies that focuses on demographic changes and their impact on carbon emissions in Nigeria includes; (AkoredeandRafia, 2020; Adamuert al., 2020; LawalandAbubakar, 2019; Sulaimanand Abdul-Rahim, 2018; Liddle, 2015).

This study will bridge the literature gap by inculcating the variables of both financial development and demographic changes into a model to examine their respective impacts on carbon emission in Nigeria. Furthermore, the study is a most recent analysis on the subject topic which bridges the gap of period in the research of financial development and demographic changes and how it has impacted on carbon emission in Nigeria.

2.0 Literature Review

2.1 Understanding the Concepts of Financial Development

Financial development denotes the progression through which financial systems, institutions, and markets develop and expand, thereby enhancing accessibility to financial services and fostering greater involvement in financial markets. It is widely acknowledged that financial development plays a crucial role in propelling economic growth and advancement by facilitating individuals, enterprises, and governmental bodies to secure the necessary funds for investing in productive ventures. According to Levine et al. (2000), a robust financial system is deemed to be the driving force behind economic growth. Additionally, Tamazian, et al. (2009) contend that financial development directly influences energy consumption and, consequently, carbon dioxide emissions. Noteworthy contributions from (Shahbaz et al., 2013; Alam et al., 2014; Al-Mulali et al., 2015) have demonstrated that the development of the financial sector not only fosters economic growth but also mitigates energy-related pollutants.

2.2 Understanding the Concepts of Demographic Changes

Demographic change pertain to changes in the scale, configuration, and attributes of a populace over time (Bongaarts, 2009). These changes can arise from a variety of causes, such as fluctuations in birth and death rates, migration trends, and aging. According to Lim et al. (2020), demographic factors and the changes in this factors can wield a notable influence on carbon emissions, as variations in population size, age composition, and economic pursuits can impact the magnitude of greenhouse gas discharges. Hossain andHasanuzzaman (2011) have posited that an indicator of demographic variations, such as the surge in urban population density and the alteration of human conduct organization that emits carbon dioxide, can sway household energy consumption patterns (Barnes et al., 2005). Nevertheless, a comprehensive and lucid elucidation of the impact of urbanization on national energy usage and CO2 emissions remains elusive.

2.3 Relationship between Financial Development and Carbon Emissions in Nigeria

The examination of the connection between financial advancement and environmental preservation has been extensively researched, yielding conflicting empirical outcomes. The existing literature can be categorized into two primary schools of thought. The first perspective, supported by: (ClaessensandFeijen 2006;

Tamazian et al., 2020; Opaluwa, 2023), posits a negative association between financial development and CO_2 emissions, asserting that enhancements in financial systems facilitate the adoption of energy-efficient and eco-friendly production techniques, thereby improving environmental quality. Noteworthy studies in the Nigerian context indicate that financial progress leads to a reduction in carbon emissions (Omoke et al., 2020; Rafindadi, 2016; Maku et al., 2018; Ali et al., 2019), achieved through lowered production expenses, heightened product competitiveness, utilization of energy-efficient technologies, and management of energy-related costs. Conversely, the second perspective, advocated by AbbasiandRiaz (2016), contends that financial development positively impacts CO_2 emissions. Specifically in Nigeria, one study illustrates a positive correlation between financial advancement and carbon emissions: (Jakada et al., 2020; Zakari et al., 2022).
The big concern about the expected negative impact of climate change for Nigerians sustainable development by 2030 is; what specific climate finance policy instrument currently exist in Nigeria to support private sector investment in low-carbon technology-driven production systems? This question raised acknowledges that uncontrolled consumption of coal, petrol, and diesel energy, which emit high kilotons of carbon dioxide for daily business operations, will directly hinder the attainment of tomorrow's sustainable development goals of low-carbon economic growth in Nigeria (OgbuaborandEgwuchukwu 2017). According to the United Nations Climate Change Secretariat (UNFCCC, 2014), additional investment and financial flows of USD 200–210 billion will be needed in 2030 to develop an effective and appropriate international response to climate change.

2.4 Relationship between Demographic Changes and Carbon Emissions in Nigeria

The escalating demand for an environmentally sustainable economy has sparked concerns regarding population growth and urbanization trends in Nigeria. Both urbanization and population have been identified as key drivers of global CO_2 emissions. Nigeria currently boasts the largest population in Africa, surpassing 215 million individuals in 2022, with projections indicating a steady increase in the coming decades, potentially doubling to approximately 400 million by 2050. Liddle (2015) argues that the persistent population upsurge is likely to intensify energy consumption, consequently leading to a surge in CO_2 emissions within Nigeria.
Various human endeavors such as bush burning, ranching, and deforestation are identified as contributors to greenhouse gas emissions (GHG), with CO_2 constituting the primary component of GHG. These activities are anticipated to escalate alongside population expansion, as the rise in population is expected to drive an increase in human activities which directly impact the level of CO_2 been emitted.

Projections based on a 2014 assessment of the World Urbanization Prospects by the United Nations (UN) DESA's Population Division suggest that Nigeria, China, and India are poised to spearhead global urban expansion. The urban population of these three nations was forecasted to represent 37% of the global urban populace from 2014 to 2050. Notably, Nigeria's urban population is estimated to soar to 212 million individuals by 2050, with the urban population percentage in Nigeria standing at 50.84% based on the World Bank's 2013 estimation. Urbanization in Nigeria is fostering deforestation as a growing number of individuals embrace urban lifestyles, resulting in heightened resource utilization, necessitating forest clearance for urban development and heightened agricultural activities (Population Matters, 2024).

Hossain andHasanuzzaman (2011) posit that the rise in urban population can lead to an increase in energy usage, consequently fostering economic development and expanding trade relations globally, thereby potentially escalating the volume of CO2 emissions within the economy.

2.5 Theoretical Framework

The IPAT model serves as the theoretical framework underpinning this research. It posits a connection between affluence, technology, population, and environmental impact. The inception of the IPAT model is credited to Ehrlich andHoldren (1971), with Commoner (1972) and Commoner et al. (1971), responsible for its algebraic formulation and practical application.

According to IPAT, the environmental impact (I) is determined by population (P), affluence (A), and technology (T). The growth in population size, as emphasized by Ehrlich andHoldren (1971), exerts a detrimental influence on the environment through heightened demands for land, resources, and polluting practices. Affluence, typically quantified as GDP per capita, is associated with environmental deterioration, as noted by Fan et al. (2006) and York et al. (2003). Technology, with its dual potential to enhance or harm environmental quality, poses challenges in its definition within the IPAT model, as discussed by Commoner (1972). In the original IPAT equation, technology is delineated as the residual factor encompassing all variables impacting the environment beyond population and affluence (Chertow, 2000). It gauges the resource intensity of current affluence per capita output, reflecting the extent of environmental harm in the creation, transportation, and disposal of goods and services. Advancements in technology have the capacity to optimize production efficiency and diminish resource intensity, thereby mitigating the amplifying impact of technology (Commoner et al., 1971).

$$I = P \times A \times T \qquad (1)$$

The IPAT equation explains that the environmental impact is a function of population, affluence, and technology. When the factors on the right side of the equation are multiplied, only one parameter can be altered while the rest remain constant to observe the influence of each individual factor. To address this constraint, Dietz and Rosa (1994) introduced a stochastic framework known as STIRPAT (Stochastic Impacts by Regression on Population, Affluence, and Technology). The primary objective of the STIRPAT model is to examine the disproportionate effect of a specific variable on the environment. Additionally, the STIRPAT model enables the regulation of technology instead of treating it as a residual component (Dietz and Rosa, 1994) Empirical Review

2.6 Empirical Analysis

Zakari et al.(2022), using data from 1981–2021, explored the Impact of Carbon Dioxide Emissions and Financial Development on Economic Growth in Nigeria: An ARDL Approach. The results of the estimation show that rising emissions have a significant and positive impact on economic growth in Nigeria. Rehman et al. (2022) in their study on sustainable development and pollution: the effects of CO2 emission on population growth, food production, economic development, and energy consumption in Pakistan from 1975 to 2019 using the linear autoregressive distributed lag technique (ARDL). The study's result shows that, in the long term, fossil fuels and renewable energy, CO2 emissions, and GDP per capita positively affect economic development, while electricity, nuclear power, and energy use harm it. In the short term, these factors impact economic growth similarly, but electricity consumption, nuclear electricity, and energy use negatively impact growth.

Steve et al. (2022) on renewable energy consumption as a panacea for sustainable economic growth: panel causality analysis for African blocs 1990–2018 used the CCEMG and Dumitrescu-Hurlin Granger causality tests. The result of the study shows that renewable energy slowed economic growth in East, West, and Central Africa. The growth hypothesis for East and West Africa and the feedback hypothesis for Central Africa, respectively, were supported by the Granger causality test. Jakada et al. (2020), study of financial development and environmental quality in Nigeria from the 1970s to 2018 using a non-linear ARDL approach. The result of the study concluded that financial development in Nigeria impedes the quality of the environment. Sulaimanand Abdul-Rahim (2018) did a study on population and carbon emission in Nigeria using data from the years 1976–2010 and the auto-distributed lagged model (ARDL). The study's result shows that population growth lacks significant long-run effects on CO2 emissions.

Bist (2018), in a study of 16 low-income countries from the years 1995 to 2014, using panel unit root and panel co-integration analysis, shows that most countries' economic growth is positively impacted by their financial development. Alege et al. (2017), on their study of carbon emissions and the business cycle in Nigeria, from 1981-2015. Used the structural vector autoregressive approach. The researchers found that an increase in CO2 emissions has a positive and significant effect on GDP in Nigeria.

3. Methodology

3.1 Research Design

The exploratory design is used to compile relevant information from a range of sources, including journal articles and textbooks. On the other hand, the ex-post facto design is selected because of its intrinsic limitation of not permitting control over variables, mostly because they have already occurred and cannot be changed.

3.2 Research Approach

The research approach used in this study is the vector error correction model (VECM). This would be used to establish the short run and long run relationship between the dependent and independent variables of the model. The pre-estimation tests that will be conducted are: unit root stationarity test, lag length selection criterion and johansen co-integration test.

3.3 Model Specification

The VECM model capturing the variables of the model and which will establish the objectives of the study is illustrated below:

Expressing the functional relationship in linear econometric form:

Co2 = f(fdi, cpb, upr,gdp,bms,pd,pgr) (2)

Expressing the functional relationship in linear econometric form

$$Co2 = = \alpha_0 + \alpha_1 fdi + \alpha_2 cpi + \alpha_3 upr + \alpha_4 gdp + \alpha_5 bms + \alpha_6 pd + \alpha_7 pgr + \mu \quad (3)$$

For econometric analysis and to avoid the problem of heteroskedasticity, the functional equation transformed into a log linear econometric function gives;

$$logCo2 = = \alpha_0 + \alpha_1 logfdi + \alpha_2 logcpi + \alpha_3 logupr + \alpha_4 glogdp + \alpha_5 logbms + \alpha_6 logpd + \alpha_7 ploggr + \mu \quad (4)$$

*the*VECM equation for the model is specified as thus:

$$logCO2_t = \delta + \sum_{i=1}^{k-1} \beta_i logco2_{t-1} + \sum_{j=1}^{k-1} \Omega_j \, logfdi_{t-1} + \sum_{n=1}^{k-1} \Upsilon_n \, logcpi_{t-1} + \sum_{m=1}^{k-1} \eta_m \, logupr_{t-1} + \sum_{p=1}^{k-1} \psi_p \, loggdp_{t-1} + \sum_{q=1}^{k-1} \mathcal{S}_q \, logbms_{t-1} + \sum_{r=1}^{k-1} \curlywedge_r \, logpd_{t-1} + \sum_{s=1}^{k-1} \mho_s \, logpgr_{t-1} + \mu_{it} - \lambda ECT_{t-1}$$

(5)

.Where: k-1= the lag length reduced by 1

- logco2 = Carbon Emissions_kt as dependent variable.
- Logfdi = foreign direct investment (an indicator of financial development)
- Logcpi = domestic credit to private as percentage of gdp (indicator of financial development)
- Logupr = urban population growth rate (demographic change indicator)
- Loggdp= gross domestic product (indicator of financial development)
- Logbms = broad money (indicator of financial development)
- Logpd = population density (demographic change indicator)
- Logpgr = population growth rate (demographic change indicator)
- δ the model intercept
- β_i ,Ω_j,Υ_n,η_m,ψ_p, $\mathcal{S}_q$,$\curlywedge_r$, $\mho_s$= short run dynamic coefficient of the model's adjustment long run equilibrium
- $-\lambda$ = speed of adjustment parameter with a negative sign
- ECT_{t-1} = the error correction term.
- μ_{it} = Error term.

3.5 Sources of Collected Data

Table 1: Unit of measurement and sources of variables

Variable Definition	Unit of Measure	Source of Data
Domestic Credits to Private Sector by Banks (% of GDP) (CPI)	Financial Development Independent Variable	World Development Indicator databank (WDI)
Foreign Direct Investment (FDI) as percentage of GDP	Financial Development Independent Variable	World Development Indicator databank (WDI)
Gross Domestic Product (GDP)	Financial Development Independent Variable	World Development Indicator databank (WDI)
Broad Money (BMS)	Financial Development Independent Variable	World Development Indicator databank (WDI)
Population Growth Rate (PGR)	Demographic Change Independent Variable	World Development Indicator databank (WDI)
Urban Population Growth (UPR)	Demographic Change Independent Variable	World Development Indicator databank (WDI)
Population Density (PD)	Demographic Change Independent Variable	World Development Indicator databank (WDI)

Carbon Emission (C02)	Dependent Variable	World Development Indicator databank (WDI)

Source: World Bank Database (data.worldbank.org)

4.0 Result

4.1 Unit Root Test

Table 1: Augmented Dickey Fuller (ADF) Unit Root Test

Variables	ADF At Levels		ADF after 1st Difference	
	ADF Test Statistics	p-value of z(t)	ADF Statistics	p-value of z(t)
logco2	-2.4700	0.3433	-4.7150	0.0007
Logfdi	-3.0320	0.1234	-6.4800	0.0000
Logupr	-2.5830	0.2876	-7.9080	0.0000
Loggdp	-1.5010	0.8286	-4.1340	0.0056
Logcpi	-2.5140	0.3208	-4.9800	0.0002
Logbms	-2.0980	0.5475	-3.8160	0.0158
Logpd	-2.2390	0.4681	-5.9340	0.0000
Logpgr	-1.5630	0.8065	-4.7740	0.0005

Source: Author's computation from STATA Statistical software

Table 1 shows the result of Augmented Dickey Fuller Unit Root test. The result shows that all the variables of the models are all non-stationary at levels. After first difference the variables all became stationary prompting a pre-condition for a long run co-integration amongst the variables of the model. The p-value of the ADF unit root tests at level are all greater than 0.05 ($p>0.05$), this prompted a first differencing of all the variables and the p-values of the variables became stationary after first difference at p-value less than 0.05 ($p<0.05$).

This necessitate the further check for the long run co-integration analysis using Johansen test. But before then, the study opt to find the optimum lag length selection criterion.

4.2 Maximum Length Selection Criteria

Adopting the Akaike information criterion, the maximum lag length of the model is 2

Table 2: Summary of maximum length selection criterion

Lag	**LL**	**LR**	**FPE**	**AIC**	**HQIC**	**SBIC**
0	146.4590	.	7.00E-15	-9.8899	-9.7735	-9.5093
1	374.6230	456.33	6.80E-20	-21.6160	-20.5687	-18.1903
2	487.1400	225.03*	8.40E-21	-25.0814*	-23.1033*	-18.6107*
3	.	.	-2.4e-97*	.	.	.

Source: Author's computation from STATA 13 Statistical Software

4.3 Johansen Unrestricted Co-integration Rank Test (Trace)

Table 3: Result of Johannsen Co-integration test

maximum					**5% Critical value**
Rank	**Parms**	**LL**	**eigen value**	**trace statistic**	
0	72	353.7926	.	283.4826	1.56E+02
1	87	394.4314	0.9394	202.2051	124.2400
2	100	429.3683	0.9101	132.3313	94.1500
3	111	453.9454	0.8164	83.1771	68.5200
4	120	472.2075	0.7162	46.6530*	47.2100
5	127	484.0598	0.5584	22.9484	29.6800
6	132	490.7102	0.3679	9.6476	15.4100
7	135	495.3308	0.2729	0.4064	3.7600
8	136	495.534	0.0139		

Source: Author's computation from STATA Statistical software

Table 3, shows the Johansen co-integration test on the impact of financial development and demographic change. The result indicates that in both trace and maximum eigenvalue test, the results suggests we reject the null hypothesis that 'no long run co-integrating relationship exists between the variables of the model'.

Under the 5% significance level rule, it can be deduced that four (4) positive long-run relationship exists.

This means there are long-term equilibrium relationships among the variables. On the premise of the existence of co-integration relationships, VEC modeling can be further conducted.

4.4 Vector Error Correction Result

Table 4: Result of VECM short Run equation Output

	Coef.	Std. Err	Z	P>z	[95% Conf. interval	
ECT (L1)	-0.68835	0.32356	-2.13	0.033	-1.32252	-0.05418
logco2 (LD)	0.23899	0.205584	1.16	25%	-0.16395	0.641927
logfdi(LD)	0.014099	0.035418	0.4	0.691	-0.05532	0.083518
logupr(LD)	-0.12268	0.306408	-0.4	0.689	-0.72323	0.477865
loggdp(LD)	-0.04667	0.092221	-0.51	0.613	-0.22741	0.134083
logcpi(LD)	0.13479	0.131826	1.02	0.307	-0.12358	0.393165
logbms(LD)	-0.14372	0.138	-1.04	0.298	-0.4142	0.126752
logpd(LD)	-3.28482	4.407647	-0.75	0.456	-11.9237	5.354011
logpgr(LD)	-2.31989	1.667575	-1.39	0.164	-5.58828	0.948498
Cons	0.18389	0.110037	1.67	0.095	-0.03178	0.399559

Source: Author's computation from STATA 13 Statistical Software

Table 4, shows the result of the Vector error correction model. The result shows that 68.84% of the deviation from equilibrium or error term in last period is corrected for in the present period. Table 4 further shows that the short run estimates of the model are all statistically non-significant as the p-value of the variables are all greater than 5% (p-value>0.05) hence we conclude that the explanatory variables of the model do not explain variation in carbon emission (logco2) in the short run.

4.3.1 VECM Long Run Normalization Equation

Table 5: Result of VECM long run normalization equation

Coef.	Std.	Err.	z	P>z [95%	Conf. Interval]	
logco2	1	.	.	.	.	.
Logfdi	0.075529	0.0094007	8.03	0.000	0.057104	0.093954
Logupr	0.218321	0.094932	230%	0.021	0.032257	0.404384
Loggdp	0.296253	0.0260452	11.37	0.000	0.245205	0.3473
logc2p	0.354632	0.0214856	16.51	0.000	0.312521	0.396743
Logbms	-0.06085	0.021389	-2.84	0.004	-0.10277	-0.01892
Logpd	-1.74873	0.1113497	-15.7	0.000	-1.96697	-1.53049
Logpgr	-3.12011	0.3648685	-8.55	0.000	-3.83524	-2.40499
_cons	-8.13476	.	.	.	.	.

Source: Author's computation from STATA 13 Statistical Software

Table 5, shows the long run normalization result from STATA output which are always interpreted by reversing the signs of the variable estimates. Hence we can deduce form the long run normalization output of the VECM that:

Foreign direct investment (logfdi), urban population growth rate (logupr), gross domestic products (loggdp), and domestic credit to private sector (logcpi) all exhibits a negative impact on carbon emission in the long run. The result shows that for logfdi, a unit increase in logfdi results in a 0.0755% decrease in carbon emission, when logupr increase by a unit, a carbon emission decrease of 0.2183 units is observed. Loggdp unit increase will result in a 0.2962 unit decrease in carbon emission. Furthermore a unit increase in logcpi will result in a 0.3546 decrease in carbon emission in the long run. The p-value for these variables are all statistically significant at 5% (p-value < 0.05).

However, some of the variables shows difference in their longrun relationship with carbon emission, the estimate of the model shows that; broad money (logbms) exhibits a positive relationship with carbon emission (logco2) in the long run. Also population density (logpd) also exhibits a positive relation with carbon emission in the long run and lastly, population growth rate also exhibits a positive relationship with carbon emission in the long run. The statistics further shows that a unit increase in logbms results in a 0.06 unit increase in logco2, while a unit increase in logpd results in 1.7487 unit increase in logco2, lastly a unit increase in logpgr results in a 3.1201 increase in logco2.

4.4 Post-estimation Diagnostic Tests

Table 6: Result of Diagnostic Tests

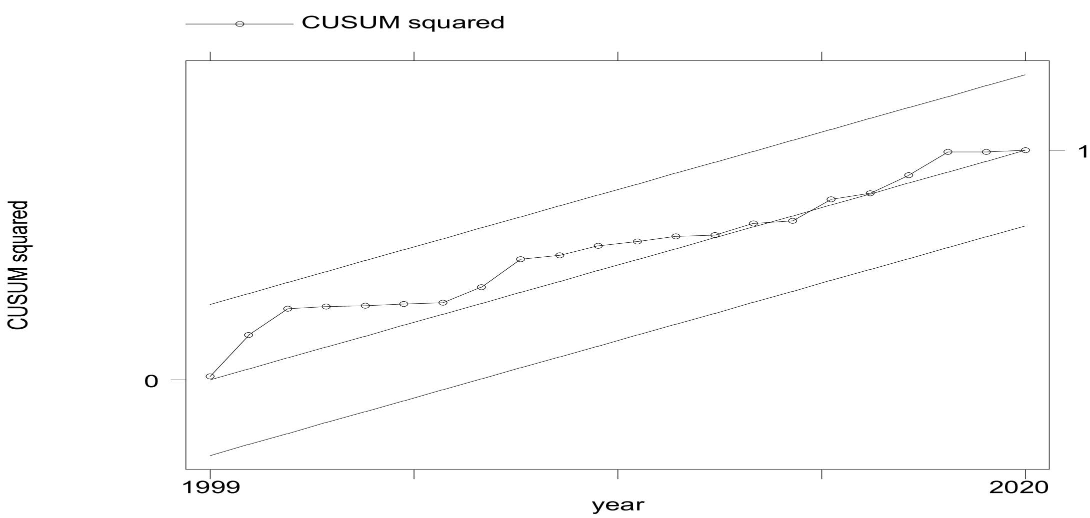
Heteroscedasticity Test	Chi2= 0.80	p-value>chi2 = 0.3697
LM Test for Autocorrelation	Chi2 = 45.4316	p-value>chi2 = 0.96191
Ramsey Test	F(3, 19) = 1.63	Prob> F = 0.2169

Source: Author's Computation from STATA Statistical Software

Table 6, shows the results of the diagnostic tests. The result shows that the test statistics for heteroscedasticity is 0.8 with a P-value greater than 0.3697 which is greater than 5%. Hence, there is no heteroscedasticity in the error terms. This is desirable for the study because it signifies that there is no heteroscedasticity problem in the model and that the variance of the residual terms is homoscedastic.

The LM test for autocorrelation also shows that the value of the LM test is 45.4316 while the p-value is 0.91 which is greater than the 5% significance level, indicating that there is no problem of autocorrelation in the model of the study.Furthermore, the Ramsey Reset F-statistic is 1.63 with a probability of 0.2169 which is greater than p-value of 0.05. This finding illustrates that there is no problem of misspecification in the estimated model.

Figure 1: Cussum Test



Source: Author's computation from STATA 13 Statistical Software

Figure 3.1, Shows the cusum test of stability. The result of the cusum square graph shows that the parameters of the model lies between the 5% boundary lines signifying that the variables of the model are stable.

4.5 Granger causality Wald Tests

Table 7: Granger causality test Analysis

Causality in Panel A	chi2	prob> chi2	Causality in Panel B	chi2	prob> chi2	Result
logco2-logfdi	4.989	0.083	logfdi-logco2	0.604	0.739	No Causality
logco2-logupr	7.2504	0.027	logupr-logco2	28.145	0.000	Yes (Bi-Directional)
logco2-loggdp	24.256	0.000	Loggdp-logco2	11.854	0.003	Yes (Bi-Directional)
logco2-logc2p	0.44623	0.800	logc2p-logco2	4.2396	0.120	No Causality
logco2-logbms	8.1621	0.017	Logbms-logco2	1.769	0.413	Yes (Uni-Directional)
logco2-logpd	16.673	0.000	logpd-logco2	0.769	0.681	Yes (Uni-Directional)
logco2-logpgr	8.489	0.014	logpgr-logco2	4.7294	0.094	Yes (Uni-Directional)

Source: Author's computation from STATA 13 Statistical Software

Table 7 shows the outcome of the Granger Causality Wald Test. The result summary shows that logfdi and logc2p has no granger causality with logco2 while, logupr and loggdp shows a bi-directional granger causality with logco2. Finally, logbms, logpd and logpgr all exhibits a unidirectional granger causality with logco2.

4.0 Discussion

The result from the VECM analysis shows that in the long run, CPI, FDI, and GDP exhibit a negative relationship with carbon emissions. The broad money supply, though, showed a positive relationship with carbon emissions in the long run. This result shows that three of the four financial development indicators all show a positive impact on environmental quality, as an increase in these variables results in a reduction of carbon emissions in Nigeria in the long run. There are a series of studies that show similarity with the findings of this paper (Omoke et al., 2020; Maku et al., 2018; Rafindadi, 2016). These studies found a negative relationship between financial development and carbon emissions in Nigeria.

The result of demographic change on carbon emissions in the model was captured by the variables urban population growth rate (UPR), population growth rate (PGR), and population density (PD). The impact of population growth rate on carbon emissions indicates a positive relationship; this findings show similarities with the study by LawalandAbubakar (2019), where they find that population growth is associated with increased energy demand, transportation emissions, and industrial activities, all of which contribute to higher carbon emissions. The findings of this study further show a negative relationship with carbon emissions. This finding shows a similar outcome to the finding by AkoredeandRafia (2020), where they found that the urban population has a negative but significant impact on CO2 emissions in Nigeria. Lastly, population density has a positive impact on carbon emissions, showing similarity with the findings of Adamu et al. (2020). Their findings show that higher population densities lead to greater demand for transportation services, resulting in higher carbon emissions.

5.0 Conclusion

This study is on the impact of financial development and demographic changes on carbon emissions in Nigeria. The study employed time series data spanning from 1990 to 2020. Using the vector error correction model, the study was able to give answers to the research question and establish the objectives of the study, which are to ascertain the impact of financial development on carbon emissions and also to establish the impact of demographic changes on carbon emissions.

The study concludes that growth and development of the Nigerian financial sector will result in a reduction of carbon emissions in the long run in Nigeria, while an increase in population will translate into increased carbon emissions in Nigeria. Also, the urban population increase will reduce carbon emissions in the long run as technology improves and the environmental Kuznet theory is achieved in the urban area of Nigeria in the long run.

6.0 Recommendation

The study recommends that:

i. The expansion of the Nigerian financial sector should be encouraged by all stakeholders, and activities of the sector that directly impact better environmental quality should be encouraged.
ii. Collaborative efforts by financial institutions and the government should be encouraged in areas of jointly addressing the challenges of climate change mitigation. Collective action and shared responsibility are essential for achieving sustainable development goals.
iii. As increased population growth rate and population density have a mitigating effect on the quality of the environment in the long run, there should be an increase in advocacy and environmental education programs, awareness, and campaigns to engage individuals, communities, and stakeholders in efforts to address climate change and reduce carbon emissions.
iv. Voluntary family planning services should be encouraged, as should the promotion of reproductive health education to empower individuals and couples to make informed choices about family size and spacing. By reducing the birth rate, the population growth rate can be reduced, which helps mitigate future increases in carbon emissions associated with population growth.

References

1. *Abbasi, F andRiaz, K. (2016). CO2 emissions and financial development in an emerging economy: an augmented VAR approach," Energy Policy, vol. 90, pp. 102–114, 2016*
2. *Alege, P. O.,Oye, Q.,Adu. O. O., Amu, B. andOwolabi, T. (2017). Carbon Emissions and the Business Cycle in Nigeria. International Journal of Energy Economics and Policy, 7(5), 1-8.*
3. *Ali, H.S., Law, S.H., Lin, W.L., Yusop, Z., Chin, L. and Bare, U.A. (2019). Financial Development and Carbon Dioxide emissions in Nigeria: evidence from the ARDL bounds approach. GeoJournal, vol. 84, no. 3, pp. 641–655, 2019*
4. *Al-Mulali, U., Chong, W.W., Low, ST. and Mohammed AH. (2015). Investigating the Environmental Kuznets Curve (EKC) hypothesis by utilizing the ecological footprint as an indicator of environmental degradation. Ecological Indicators, 48, pp. 315-323.*
5. *Akorede, Y.F andRafia A. (2020). The relationship between urbanization, CO2 emissions, economic growth and energy consumption in Nigeria. In: International Journal of Energy Economics and Policy 10 (6), S. 491 – 501*

6. *Adamu, S., Danjuma, M. andBabaji, M. (2020). An analysis of the long run effects of economic growth, urbanization and population density on transport emissions in Nigeria: A bounds testing approach. International Journal of Intellectual Discourse. Volume 3, Issue 2. PP.146-162*
7. *Ayinde, O., Ajewole, O., Ogunlade, I. andAdewumi, M. (2010). Empirical analysis of agricultural production and climate change: A case study of Nigeria. Journal of Sustainable Development in Africa. Volume 12, No.6 pp. 275-283*
8. *Bongaarts J. (2009). Human population growth and the demographic transition. Philosophical transactions of the Royal Society of London. Series B, Biological sciences, 364(1532), 2985–2990.*
9. *Bist, J. P. (2018). Financial development and economic growth: Evidence from a panel of 16 African and non-African low-income countries. Cogent Economics and Finance, 6(1), 1449780*
10. *Chertow, M. (2000). The IPAT Equation and Its Variants. Journal of Industrial Ecology, 4(4), pp.13-29.*
11. *ClaessensandFeijen. (2006). Financial Sector Development and the Millennium development Goal. World Bank, Washington DC, USA*
12. *Commoner, B., Corr, M. andStamler, P. (1971). The causes of pollution. Environment: Science and Policy for Sustainable Development, 13(3), pp.2-19.*
13. *Dietz. T, T. and Rosa, E. (1994). Rethinking the Environmental Impacts of Population, Affluence and Technology'. Human Ecology Review, [online] 1(2), pp.277-300. Available at: www.humanecologyreview.org*
14. *Ehrlich, P. and Holdren, J. (1971). Impact of Population Growth. Science, New Series, 171(3977), pp.1212-1217.*
15. *Fallahi, F. (2020). Persistence and unit root in CO2 emissions: Evidence from disaggregated global and regional data. Empir. Econ. 58, 2155–2179.*
16. *Fan, Y., Liu, L., Wu, G. and Wei, Y. (2006). Analyzing impact factors of CO2 emissions using the STIRPAT model. Environmental Impact Assessment Review, 26(4), pp.377-395.*
17. *Hossain, A. K., andHasanuzzaman, S. (2012). The Impact of energy consumption, urbanization, financial development, and trade openness on the environment in Bangladesh: an ARDL Bound Test Approach. Shahjalal University of Science and Technology.*
18. *IPCC, 2012: Summary for Policymakers, (2018). Routledge. pp. 111–128.*
19. *Jakada, A.H., Mahmood, S., Ahmad, A. U., Farouq, I.S. and Mustapha, U.A (2020) Financial Development and the Quality of the Environment in Nigeria: An Application of Non- Linear ARLD Approach, journal of Research in World Economy, Vol. 11, No. 1.*

20. *Javid, M and Sharif, F. (2016), Environmental Kuznets curve and financial development in Pakistan, Renewable and Sustainable Energy Reviews, 54, issue C, p. 406-414, EconPapers.repec.org*
21. *Lawal, I.M andAbubakar, M. (2019). Impact of population growth on Carbon Dioxide (CO2) emission: empirical evidence from Nigeria. JurnalPerspektifPembiayaandan Pembangunan Daerah Vol. 6. No. 6, ISSN: 2338-4603 (print); 2355-8520*
22. *Levine, R., Loayza, N., and Beck, T., (2000). Financial intermediation and growth: causality and causes. Journal of Monetary Economics 46, 31–77.*
23. *Liddle, B. (2015). What are the carbon emissions elasticities for income and population? Bridging STIRPAT and EKC via robust heterogeneous panel estimates. Global Environmental Change, 31, 62-73.*
24. *Lim, H., Kim, J., and Jo, H. H. (2020). Population Age Structure and Greenhouse Gas Emissions from Road Transportation: A Panel Cointegration Analysis of 21 OECD Countries. International journal of environmental research and public health, 17(21), 7734.*
25. *Lise, W. (2006) Decomposition of CO2 Emissions over 1980 – 2003 in Turkey. Energy Policy, 34(14):1841-1852.*
26. *Maku, O.E., Adegboyega, S.B., andOyelade, A.O (2018) The Impact of Foreign Direct Investment On Co2 Emission In Nigeria 1980 – 2014, International Journal of Scientific and Engineering Research Volume 9, Issue 2, February Issue, IJSER www.ijser.org*
27. *Ogbuabor, J.E. andEgwuchukwu, E.I. (2017). The Impact of Climate Change on the Nigerian Economy. International Journal of Energy Economics and Policy, 7(2), 217-223.*
28. *Omoke, P.C., Opuala-Charles, S. andNwani C. (2020). Symmetric and asymmetric effects of financial development on carbon dioxide emissions in Nigeria: Evidence from linear and nonlinear autoregressive distributed lag analyses. Energy Exploration and Exploitation. 38(5):2059-2078.*
29. *Opaluwa, O.S. (2023). Impact of Financial Development and Demographic Changes on Carbon Emission in Nigeria (1990–2020). (Unpublished doctoral dissertation). University of Nigeria Nsuka, Nigeria*
30. *Population Matters, (2024). Population and the Environment in Nigeria – Too Big to Go Green? populationmatters.org (Assessed on: 12th April 2024)*
31. *Rafindadi, A. A. (2016). Revisiting the concept of environmental Kuznets curve in period of energy disaster and deteriorating income: Empirical evidence from Japan. Energy Policy, 94, 274-284.*
32. *Shah, S. A. R., Naqvi, S. A. A., Anwar, S., Shah, A. A., and Nadeem, A. M. (2022). Socio-economic impact assessment of environmental degradation in Pakistan:*

fresh evidence from the Markov switching equilibrium correction model. Environment, Development and Sustainability, 1-31.

33. *Shahbaz, M., Muhammad Q.H, Tiwari, A.K andLeitao, N.C. (2013). Economic growth, energy consumption, financial development, international trade and CO2 emissions in Indonesia, Renewable and Sustainable Energy Reviews, Volume 25, Pages 109-121*
34. *Steve, Y. S., Murad, A. B., Gyamfi, B. A., Bekun, F. V., andUzuner, G. (2022). Renewable energy consumption a panacea for sustainable economic growth: panel causality analysis for African blocs. International Journal of Green Energy, 19(8), 847-856.*
35. *Sulaiman, C., and Abdul-Rahim, A. S. (2018). Population growth and CO2 emission in Nigeria: a recursive ARDL approach. Sage Open, 8(2), 2158244018765916.*
36. *Tamazian, A., Pineiro, JC. andVadlamannati, KC. (2009) Does higher economic and financial development lead to environmental degradation: Evidence from BRIC countries? Energy Policy, 37, pp. 246–253*
37. *Tamazian, A., Chousa, A.P. andVadlamannati, K.C (2020). Does higher economic and financial development lead to environmental degradation: evidence from BRIC countries? and, vol. 37, no. 1, 79-88*
38. *Tao, M., Sheng, M. S., and Wen, L. (2023). How does financial development influence carbon emission intensity in the OECD countries: some insights from the information and communication technology perspective? Journal of Environmental Management, 335, 117553.*
39. *United Nations, (2012). The future we want. Outcome document of the United Nations Conference on Sustainable Development, Rio de Janeiro, Brazil.*
40. *United Nations, (2014). United Nations Climate Change Secretariat. UNFCCC, Bonn.*
41. *UNCCD (United Nations Convention to Combat Desertification), (2013). Climate change financing opportunities for sustainable land management in Africa: lesson learned and the way forward. UNCCD, Paris.*
42. *United Nations Framework Convention on Climate Change (UNFCCC), Investment and financial flows to address climate change, (2007).*
43. *United Nations Environment Programme (UNEP), Guidebook to Financing CDM projects*
44. *World Bank (2024). World Bank Development Indictor: Nigeria Assessed from: data.worldbank.org*
45. *Zakari, J., Haruna, I.A and Umar, A. (2022). Impact of Carbon Dioxide Emissions and Financial Development on Economic Growth in Nigeria: An ARDL Approach. Gusau International Journal of Management and Social Sciences, Vol.5, No.3, October, 2022 ISSN (p): 2735-9026, ISSN(e): 2787-0383 130*