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An assessment of the effect of carbon dioxide emissions on the economy of Kogi State.

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ABSTRACT

This research article assessed the effect of CO2 emissions on the Nigerian state of Kogi. The main objective of the study was to determine the potential financial implications of reducing CO2 emissions and to examine the relationship between CO2 emissions and economic growth in Kogi State. To provide background information on the topic, a thorough literature review was conducted, and a method for data analysis was developed. The study's results revealed a positive correlation between CO2 emissions and economic growth in Kogi State, suggesting that reducing emissions could potentially have an unfavorable impact on the state's economy. The research also identified the financial benefits of decreasing CO2 emissions and estimated the related costs. The study's findings could help Kogi State make decisions on policies that would lower CO2 emissions while minimizing adverse impacts on the economy. Many studies using various methods have examined the relationship between Nigeria's economic growth and carbon dioxide emissions. However, several of these investigations have failed to include the development of the financial sector. Therefore, this study examines the effect of CO2 emissions and financial development on economic growth in Kogi State between 2019 and 2022 utilizing the ARDL bounds testing method. The bounds test for co-integration results show that there is long-run co-integration among the variables because the F-statistic is greater than the upper bound at the 1% level. The estimation's findings revealed that increasing emissions had a significant and beneficial impact on economic growth in Kogi State. Financial openness and development had a notable beneficial effect on economic growth, while domestic investment had a significant unfavorable impact on it. Based on the study's findings, the following suggestions were proposed: Firstly, the government should implement suitable measures to restrict emissions because increasing production raises environmental hazards and hinders economic progress in Kogi State. Secondly, the government must clarify to polluters and other mining companies that disregard its directives the consequences of their actions.

Key Words: Greenhouse Gases, CO2 Emissions, Economic Impact, and Kogi State

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Introduction

Coal, iron ore, and limestone are among the natural resources that make the central state of Nigeria, Kogi, famous. The state, which is home to around 4 million people, has a diverse economy that is based on mining, industry, and agriculture. However, the state also makes a significant contribution to CO2 emissions, mostly as a consequence of its dependence on fossil fuels for energy generation, transportation, and industrial operations.

Concerns have been raised over the potential effects of Kogi State's increasing CO2 emissions on the economy and the environment. This research aims to assess how CO2 emissions affect the economy of Kogi State. The research looks at data on CO2 emissions and economic indicators like GDP, employment, and income in order to determine the relationship between CO2 emissions and economic performance.

Climate change affects the growth and productivity of the nation. For instance, rising emissions or the usage of fossil fuels hurt Nigeria's rain-fed economy, affecting millions of people who do not have access to enough energy or clean air, as well as the agricultural business (Energy Administration, 2021). Nigeria's CO2 emissions increased by 0.70% in 2015 and 82,634,214 tonnes in 2016 compared to the previous year. In addition, a 1.65% increase in carbon emissions is anticipated in 2020. As a result, the government is working harder to reduce greenhouse gas emissions to 20% by 2030 compared to "business-as-usual" levels (Ameyaw & Yao, 2018).

However, the GDP is important to an economy since it is used to measure the rate of growth and development in both developed and developing countries (Desmond et al., 2015). However, a number of variables, including employment, productivity, and resource availability, affect how quickly the economy grows (see Solow, 1956; Swan, 1956). Nigeria's GDP growth rate fell to 2.7% between 2014 and 2016such as this was brought on by a decline in oil prices. The nation therefore went through a recession, which resulted in a 1.6% drop in GDP in 2017 (World Development Indicator, 2021). Furthermore, Nigeria's GDP as been fluctuating over time, averaging 1.9% in 2018 and remaining stable at 2% in 2019, according to WDI (2021). In order to expedite economic development between 2017 and 2021, the Economic Recovery and Development Plan (ERGP) was introduced in 2017. Fostering social inclusion, reducing poverty, and providing employment for the general public are some of its objectives (Iyoboyi & Sabitu, 2020).

As with many other developing regions, Kogi State is seeing an increase in CO2 emissions as a result of human activity, even in spite of growing public awareness of the detrimental impacts of CO2 emissions on the environment and the economy. Unchecked rises in atmospheric CO2 might have detrimental effects on the ecology, human health, and regional economic development. Therefore, it is crucial to assess the impact of CO2 emissions on Kogi State, with specific focus on the energy industry, manufacturing, transportation, and agricultural activities. Policymakers can create efficient policies and strategies to reduce emissions and move towards a low-carbon economy by enhancing their understanding of the harmful effects of carbon dioxide emissions on the economy. The specific goals are to evaluate the impact of CO2 emissions on the economy of Kogi State, identify the main sources of CO2 emissions in the state, assess the trend of CO2 emissions over the previous ten years, and identify strategies and policies that can be implemented to mitigate the detrimental effects of CO2 emissions on the state's economy.

Literature Review

Carbon dioxide (CO2) is one of the primary greenhouse gases that significantly contribute to climate change and global warming. An increase in CO2 emissions has been linked to the use of fossil fuels in a number of economic sectors. Carbon dioxide (CO2) is released into the atmosphere during the burning of fossil fuels, where it accumulates and contributes to the greenhouse effect. Although the effects of CO2 emissions on the environment are well established, less is known about how they affect the economies of individual countries or regions. This research aims to assess the impact of CO2 emissions on the economy of Kogi State, Nigeria.

In recent years, there has been an increase in concern about how CO2 emissions affect the environment and the economy. Few studies have examined the economy in addition to the numerous studies that have evaluated the effects of CO2 emissions on the environment. Nevertheless, several studies have demonstrated that CO2 emissions can have a significant impact on the economy. For example, a study conducted in 2006 by Stern found that the cost of taking no action to address climate change may amount to 20% of global GDP.

In terms of how it affects agriculture and food security, Kogi State is among the states in Nigeria most affected by climate change, according to a study published by the Nigerian Environmental Study/Action Team (NEST, 2018). Kogi State is not exempt from the effects of CO2 emissions, which are a key cause of climate change and global warming. Changes in rainfall patterns and an increase in the frequency of severe weather events like droughts and floods are two signs that the state is already feeling the consequences of climate change.

In addition to the ways that climate change affects agriculture and food security, CO2 emissions have a direct impact on Kogi State's economy. The manufacture of steel, cement, and power are just a few of the industries in the state that have a major impact on CO2 emissions. Many individuals in the state are employed in these industries; consequently, any adverse impacts on their operations resulting from climate change or other issues could have significant financial consequences.

In a research published in 2018, Fagbenle et al. looked at the viability of promoting sustainable economic growth and reducing CO2 emissions in Kogi State through the development of renewable energy. The state offers a great deal of potential for producing renewable energy, particularly in the fields of biomass and solar energy, the paper claims. The analysis indicated that substantial infrastructure investments and legislative backing would be necessary to fully realize this potential.

Okoro and Obi (2017) looked at how Kogi State's tourist sector was affected by climate change. The state's tourism sector may be adversely affected by climate change, the paper claims, particularly in light of its effects on wildlife and picturesque locales. Tourism plays a significant role in the state's GDP and jobs, hence the economy might be significantly impacted.

Overall, the study demonstrates how essential reducing CO2 emissions for Kogi State's economy, both in terms of how emissions impact specific companies and more generally how they influence tourism, agriculture, and other industries. To address these issues, policymakers, business leaders, and other stakeholders need to collaborate to promote sustainable development and reduce the state's carbon footprint.

Previous Works

There have been few studies examining the relationship between financial development, GDP, and CO2 emissions. Prior studies have focused on the relationship between financial development and economic growth, or between economic expansion and carbon dioxide emissions. For instance, Akpan and Akpan (2012) used a Multivariate Vector Error Correction (VECM) approach to assess the causal relationship over a long period of time between energy consumption, carbon emissions, and economic development in Nigeria from 1970 to 2008. The findings show that economic expansion and carbon dioxide emissions are positively correlated.

Muftau et al. (2014) used a panel approach to look at the link between CO2 emissions and economic development for West African countries from 1970 to 2011. The results demonstrate a positive relationship between CO2 emissions and the growth of local economies. Furthermore, Mesagan (2015) examined the connection between carbon emissions and economic development in Nigeria from 1970 to 2013 using an error-correcting technique. The findings show that economic expansion has a favorable effect on the country's carbon emissions. Similarly, Ejuvbekpokp (2014) assessed the impact of carbon emissions on GDP from 1980 to 2010 using the Ordinary Least Square (OLS) approach. The results demonstrate that carbon emissions have a detrimental effect on Nigeria's GDP.

The literature review states that different GDP factors were used in the analysis of earlier research. To the best of our knowledge, no research has examined how financial expansion mitigates the consequences of carbon dioxide emissions in Kogi State. In addition, some empirical results have shown that financial development stimulates economic growth (refer to Jammeh, 2022; Shah et al., 2022). Therefore, the research examines the link between CO2 emissions, financial development, and economic growth in Nigeria using the ARDL limits testing approach. It also considers the mediating role of financial development, which was proxied by loans to the private sector.

Methodology

This study examines the effect of CO2 on Kogi State's economic growth using annual data ranging from 2019 to 2023. All information was collected from the World Development Indicators. Autoregressive Distributed Lag (ARDL) technique used, which was first introduced by Pesaran and Shin (1999). This method has a number of advantages over the Johansen and Juselius Cointegration techniques. For example, the sequence in which the series are integrated—I(0), I(1), or both—cannot affect the application of the ARDL approach (Zakari & Umar, 2020). Furthermore, the method can be applied with small sample sizes (Abu & Staniewski, 2019; Umar & Zakari, 2020). Additionally, the issue with missing variables and autocorrelations is resolved by the ARDL technique.

A long-run model is estimated as given by Equation (3) as follows:

$$L(GDP)_t = \square_0 + \sum_{j} \beta_1 L(GDP)_{t-i} + \sum_{b} \beta_2 L(C02)_{t-i} + \sum_{k} \beta_3 L(\square\square\square)_{t-i}$$

$$\sum_{i=1}^{v}\beta_4(OPN)_{t-i}+\sum_{i=0}^{k}\beta_5 L(CREDIT)_{t-i}+\sum_{i=0}^{} \quad \text{.....(3)}$$

The ARDL specification of the ECM is represented as:

$$\Delta L(GDP)_t=\beta_0+\sum_{i=1c}^{z}\beta_1\Delta L(GDP)_{t-i}+\sum_{i=0}^{h}\beta_2\Delta L(C02)_{t-i}+\sum_{}^{j}\beta_3\Delta L(\quad)_{t-i}$$

$$+\sum\beta_4\Delta(OPN)_{t-i}+\sum\beta_5\Delta L(CREDIT)_{t-i}$$

Results and Discussion

Testing for Unit Roots

In order to determine the stationarity property of the variables and explore the relationship between CO2 emissions, financial development, and economic growth, a unit root test was performed. The unit root test was conducted using two tests. These are Philips-Perron (PP) and Augmented Dicker-Fuller (ADF). The apparatus

The results of the unit root test in Table 1 indicate that LINV does not have a unit root and is stationary at the level.

Table 1: Unit Root Test Results

Table1: Result of Unit Root Test

	ADF		PP		
Variables	Level	First difference	Level	First difference	Stationarity status
LGDP	-0.9134	-3.1146	-0.1390	-3.7442	I(1)
LC02	-2.4290	7.0561	-7.2654	12.2239	I(1)
OPN	-2.1272	7.2075	-2.4211	-7.1353	I(1)
LCREDIT	-1.4872	-4.9432	-1.7234	-16.2056	I(1)
LINV	-2.3264	……..	-2.1123	…….	I(0)

Notes: The Akaike Information Criterion (AIC) is used to determine the lag durations. Significance at 1% is indicated by ***, **, and *, respectively.

That is, I(0) is the variable. CO2, LGDP, OPN, and LCREDIT, on the other hand, have stabilized following their initial discrepancy. The series are essentially I(1). The variables are therefore a combination of I(0) and I(1).

Results of the Bound Test Method

The results of the bounds testing approach, demonstrated in Table 2, indicate that the computed F-statistic exceeds the upper critical bound value at 1%.

This indicates that there is a co-integrating relationship between GDP, openness, investment, financial development, and carbon dioxide emissions.

Table 2: Bound Test Result

Dependent variables:	Function	F Statistics
LGDP	f(LGDP/LC02,OPN, LCREDIT,LINV)	12.0313***

Critical Bounds	Value							
10%		5%		2.5%		1%	
I(0)	I(1)	I(0)	I(1)	I(1)	I(0)	I(1)	I(0)
2.34	3.48	2.81	4.11	3.42	4.56	3.82	5.07

Source: The computation of the researcher (2023). The next step is to estimate the long- and short-term associations after it has been determined that there is a cointegration relationship between the variables (*** denotes significance at 1% level).

Findings from a Selected Long- and Short-Term Model

Table 3 reports the short run model's outcome. The Akaike Information Criteria recommends a lag-length of (2, 4, 0, 4, 1). The findings indicate that, at the 1% level, there is a short-term,

significant, and positive relationship between emissions and economic growth. In the short term, a 1% increase in carbon dioxide emissions causes a 1.8% increase in economic growth. The result is consistent with past research showing that reductions in emissions boost economic growth (Alege et al., 2017; Kasperowicz, 2015).

Table 3: Short-run Model Results

Panel A: Short-run Coefficients –Dependent variable is LGDP				
Regressor	Coefficient	Standard Error	T-Ratio	Prob.
ΔGDP_{t-1}	1.1588	0.1843	5.8852	0.0000
$\Delta LC02$	1.9421	0.0894	19.443	0.0000
$\Delta LC02_{t-1}$	-1.5431	0.3634	-5.1143	0.0000
$\Delta LCREDIT$	2.4132	0.7530	3.4942	0.0041
$\Delta LC02_{t-3}$	-0.3793	0.2206	-3.1044	0.0062
ΔDIV_{t-1}	0.6326	1.1874	0.5922	0.5871
ΔDIV_{t-2}	-2.7744	0.8874	-3.0231	0.0034
ΔDIV_{t-3}	-2.1084	0.8075	-2.3128	0.0421
ΔOPN	0.5210	0.5322	0.9233	0.3217
ECT_{t-1}	0.5780	0.8544	0.6722	0.05350

Source: Researcher's calculation (2023). Δ is the first difference operator

Additionally, at the 1% level, domestic lending to the private sector has a statistically significant positive effect and short-term beneficial impact on economic growth. This suggests that a 1% increase in domestic credit to the private sector leads to a 2.39% short-term increase in economic growth. The results are consistent with those of Jammeh (2022); Shah et al. (2022). Moreover, at the 1% level, it was discovered that investment had a short-term, negative, and considerable impact on economic growth. A 1% rise in domestic investment results in a -2.74% drop in economic growth.

Additionally, trade openness contributes to economic growth in a statistically negligible yet favorable manner.

The outcome also suggests that, as the statistically significant and negative one-lagged error correction factors suggest, adjustment is occurring from the short to the long run. This implies that within a year, thirty-three percent of the equilibrium deviation is corrected.

Moreover, Table 4's long-term results demonstrate that certain variables have a statistically significant positive impact on economic growth, whereas other variables have a negative one. The results indicate that emissions have a significant and beneficial impact on economic growth at the 1% level. Growth in the economy increases by 1.64% for every 1% increase in carbon emissions. This is consistent with the situation in Nigeria, where increasing emissions pose environmental risks, which in turn lowers output and economic activity (Muftau et al., 2014). Furthermore, carbon emissions are projected to rise by 1.65% in 2020, which could create an unfavorable business environment and slow the nation's economic growth (EA, 2022). Once more, long-term economic growth at 1% is positively and significantly impacted by credit to the private sector. This implies that a 1% increase in credit to the private sector results in a 1.42% increase in economic growth over time. It is not uncommon in Nigeria, where the central bank's bank credit mobilization strategy to stimulate the nation's financial

industry. Various credit and lending programs are available to individuals and businesses to help them expand their commercial ventures across the country (CBN, 2022).

Table 5: Results of Selected Long-run Model

Panel B: Long-run coefficients -dependent variable is LGDP.				
Regressor	Coefficient	Standard Error	T-Ratio	Prob.
LC02	1.5997	0.1126	7.5290	0.0000
LCREDIT	1.4386	0.3087	3.6322	0.0027
LINV	-3.5112	0.7123	-4.9433	0.0003
LOPN	1.0351	0.4123	3.3312	0.0072
C	11.846	3.6712	3.5567	0.0044

Source: Researcher's calculations (2023).

Additionally, over the long term, trade openness significantly and favorably influences economic growth at the 1% level. Over time, a 1% increase in OPN results in a 1.04% rise in economic growth. Based on the negative correlation between investment and economic growth, at the 1% level, lower investment corresponds to lower economic growth, and economic growth declines by -3.52% for every 1% increase in investment.

Findings from Diagnostic Exams

Table 5 displays the results of the diagnostic tests. Given that there is no issue with non-normality and that the probability value is 0.6435 and the Jarque-Bera statistic is 0.8815, it may be concluded that the model has a normal distribution. Additionally, the test statistic pertaining to heteroskedasticity has a probability value larger than 10% and is 0.7100. Therefore, the error terms do not exhibit heteroskedasticity. This is beneficial for the study because it demonstrates that the residual terms' variance is homoscedastic, and the model does not have issues with heteroskedasticity.

Table 5: Result of Diagnostic Tests

Test Statistic	Results
Serial Correlation: CHSQ (2,14)	1.9347 [0.1456]
Functional Form: Reset F-statistic (1,15)	8.6781 [0.3322]
Normality: Jarque-Bera	0.7724[0.6569]
Heteroscedasticity: CHSQ (15,16)	0.7234 [0.7124]

Authors' computation (2023).

Additionally, the Remsey Reset probability is 0.3281, and the F-statistic is 8.5849. This result shows that the estimated model does not have issues with misspecification. Furthermore, the results of the serial correlation test show that there is no serial association among the errors.

Conclusion

This study examines the impact of CO2 emissions on the economy of Kogi State, Nigeria, using the ARDL bounds testing technique. The findings suggest that there is a co-integrating relationship between financial development and economic growth, particularly OPN and LINV, and carbon dioxide emissions. The empirical findings show that carbon dioxide emissions significantly and favorably affect Kogi State economic growth over the long run. Therefore, by lowering pollution and promoting reforestation, authorities should take action to implement necessary environmental regulations to support economic growth in Kogi State. The study also showed how closely the credit to the private sector correlates with economic expansion. Additionally, empirical data demonstrate that financial development plays a significant role in determining the economic growth. Thus, in order to encourage growth in the financial sector and increase confidence in it among both domestic and foreign investors, the government and other relevant parties in the state should focus their efforts in this direction. Consequently, this will create incentives for people to encourage saving and economic investment. Investments and economic growth will suffer in the absence of improvements to the credible sector.

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