EFFECT OFCLIMATE CHANGE ON NIGERIAN ECONOMIC SUSTAINABILITY

Abstract

Climate change isseen as a statistical variation that persists for an extended period, frequently for as long as a decade or more. Moreover, the issue of climate change which has gained global attention poses a serious threat to developing economy like Nigeria, which is characterized by widespread poverty as a result of economic instability. It is against this backdrop that this research is aimed at investigating the effect of climate change on Nigerian economic sustainability. The research made use of Autoregressive Distributive Lag (ARDL)/bond test approachand OLS estimation technique, while data for the period of 1990-2020 was collected. Changes in average temperature and carbon emission were used to capture climate change, while variation in exchange rate and agricultural production were used as control variables. The result of the analysis showed that the goodness-of-fit (R-Square) is 0.998. This means that 99.8% of the changes in the dependent variable (GDP) can be explained by the changes in the independent variables (CEM, AGRIC, EXR, TEMP). The annual speed of adjustment from short run to long run relationship is 34%. At F-statistic = 195.8052 and P value = 0.000, the model is statistically significant at 1% level. The results of the analysis further demonstrated that both in long-run and short-run, carbon emissions adversely affect Nigerian economic sustainability. Additionally, average atmospheric temperature was significantly related to sustainability of Nigerian economy in the short run. It was concluded that environmental stakeholders as well as Nigerian government should develop and enforce policies to reduce carbon emissions and forest depletion. Also, efforts should be made by government towards ensuring that policies that are environmentally friendly are made that can encourage agricultural production in order to reduce import of agricultural produce, thereby boosting economic growth.

Key Words: Climate Change, Economy, Sustainability, Carbon, Emission

Introduction

Climate change is commonly understood as a prolonged and consistent alteration in statistical patterns, typically lasting for a decade or more (Ogbuabor and Egwuchukwu, 2017). It encompasses changes in the frequency and intensity of occasional weather events, along with the gradual but ongoing increase in the global average surface temperature (Intergovernmental Panel on Climate Change [IPCC, 2001]). Climate change activities encompass phenomena such as excessive rainfall, floods, storms, drought, and heat waves. These occurrences have had an

impact on several regions worldwide, including Nigeria (Vogel and Henstra, 2015; Bushell *et al*., 2017; Nkoana et al., 2018).

Multiple studies (Adger *et al*., 2003; IPCC, 2007; Wood *et al*., 2014; Mulligan *et al*., 2016; Miah *et al*., 2017) have shown that the effects of climate change differ according on geographical areas, with certain places being more susceptible to negative impacts than others. The connection between the effects of climate change on communities and the susceptibility and ability to recover from these impacts of the affected individuals has been recognised (Schwarz *et al*., 2011; Proag, 2014; Tambo, 2016; Barret and Bosak, 2018).

In addition, the problem of climate change, which has attracted worldwide concern, presents a significant danger to developing economies such as Nigeria. Nigeria is marked by extensive poverty, vulnerable healthcare systems, and ineffective governmental institutions (Matemilola, 2019; Ucheje *et al*., 2024). However, a recent study conducted by Ucheje and Okolo (2023) has shown that the emission rate from automobiles will continue to increase, significantly contributing to climate change, unless proactive measures are taken to address this problem. Given Nigeria's status as an emerging economy, it is imperative to conduct a thorough investigation into the potential impact of climate change on Nigeria's economic sustainability in both the immediate and long-term future, in order to find viable solutions.

Literature Review

Nigeria is situated in the West African region along the Atlantic Ocean's Gulf of Guinea. It lies roughly between Latitudes 4^{O} and 14^{O} North and Longitudes 3^{O} and 15^{O} East and has a land mass of 923,768 km^2. Nigeria has a warm typical tropical climate with relatively high temperatures and two seasons (dry and wet), with the wet season lasting from April to October and the dry season fromNovember to March. The maximum temperature in the coastal areas of the south is 37°C while the minimum temperature is 10°C. The climate is dryer further north where extremes of temperature ranges from 35°C to 60°C are common. A major feature of Nigeria's coastal and marine environment is the Niger Delta, which covers an average area of 70,000 km^2, making it one of the largest wetlands in the world. The country's mangrove forests

rank as the largest in Africa and the third largest in the world (FRN, 2008). Nigeria is the most populous country in Africa, with an estimated population of over 200 million people (National Bureaucratic Statistics Nigeria, 2015).

Most of the Nigerian population live in rural areas and rely on subsistence agriculture as well as migratory livestock farming. Agriculture is a significant contributor of over 24.48% to Gross Domestic Product (GDP) for Nigeria (Ojo *et al*., 2014) as well as extraction of natural resources such as fossil fuels, metals and mining (Ebele and Emodi, 2016).Nigeria, like any other developing country, is affected by climate change and this poses a huge threat to poverty eradication and sustainable development (Ebele and Emodi, 2016; Ucheje *et al*., 2021). In terms of vulnerability, Nigeria has about 95.6 million people living in rural areas who depend on natural resources, which are climate sensitive for their livelihood (Ogbuabor and Egwuchukwu, 2017; World Bank, 2019). Rural areas and social groups were identified as the most likely to experience the effects of climate change unequally (Preston *et al*., 2014). This is in addition to Nigeria's natural ecosystems including freshwater and coastal resources that are highly exposed to the impacts of climate change prompting its classification among the ten most vulnerable countries in the world in the 2019 climate change vulnerability index (World Bank, 2019).

However, climate change can affect societal classes, income groups, occupation, age and gender in various ways and differently (Amobi and Onyishi, 2015). Due to the climate impact on agricultural sector, women will be affected disproportionally as a lot of women are poor farmers who rely on small scale and rain-fed agriculture (Onwutuebe, 2019) and will affect more women due to cultural division of roles between men and women. Women mostly depend on natural resources and are responsible for gathering wood for cooking, collecting the household water supply, and ensuring food security for the family. Children are also affected as flood could result

in their absence from schools, particularly within communities with poor transportation and scarcity of food, which could lead to hunger and undermine children's ability to learn (Amanchukwu *et al*., 2015; Ucheje *et al*., 2024).

The Nigerian economy is not left out from the climate impact, as some researchers have posited that economy of Nigeria is highly affected by climate change due to climate sensitive sector like agriculture and productivity can have an adverse effect on Gross Domestic Product (Ebele and Emodi, 2016; Ogbuabor and Egwuchukwu, 2017). Agriculture has been a source of livelihood to communities for centuries. Over 70 percent of the population depends on agriculture for their livelihood (Shiru *et al*., 2018; Onwutuebe, 2019). Nigeria resides in a semi-arid region which is largely affected by changes in temperature and rainfall, causing drought and floods, thus agriculture in these regions is predicted to become unsustainable (Ludwig *et al*., 2007). Also, many researchers have reported that climate change leads to significant decrease in agricultural productivity in Nigeria (IPCC, 2014; Onyeneke *et al*., 2017). Similarly, changes in climate is projected to affect crop cultivation and yield in most parts of the country, making it difficult for farmers to plan their operations (Ayanlade *et al*., 2017; Anabaraonye *et al*., 2019). Moreover, climate change events like flood and drought can undermine economic growth through losses in production and infrastructure and need for extraordinary spending (Ogbuabor and Egwuchukwu, 2017).

Previous efforts to tackle climate change issues in Nigeria have come from various international and national governments, citizenry and non-governmental climate agencies (Oluduro, 2012; Onyeneke *et al*., 2020). However, understanding and responding to the physical science of climate change and its unpredictability have been described as a complex problem due to the associated social, economic, ethical and political challenges (Twigger-Ross *et al*., 2016). This

may explain the difficulty of developing sound strategies in Nigeria for responding to climate change and building community resilience. Recognising the social, economic, ethical and political conundrum and its inherent features is crucial to designing sound response strategies. This has prompted suggestions for the deliberate use of decision frameworks that allow decision makers to weigh trade-offs to act in the face of incomplete information, and to learn and adjust "modus operandi" over time (Trenberth *et al*., 2018). This is crucial since climate change is posing more complex problems that far outweigh conventional solutions (Puppim de Oliveira, 2009). Nigeria has identified long-term policy measures in its national communications to the United Nations Framework Convention on Climate Change (UNFCCC), and other policy interventions. Most of the measures are yet to be fully implemented which leaves the many community members without a good understanding of the challenges faced due to climate change (Choko *et al*., 2019; Onyeneke *et al*., 2017).

~~Empirical Reviews~~

In their study, Gebreegziabher *et al*. (2011) conducted an analysis of the economic impact of climate change on agricultural productivity in Ethiopia. They utilised a comprehensive computable general equilibrium (CGE) model that covered the entire country. The study found that the overall effects of climate change will be largely harmless until around 2030, but will then significantly deteriorate. Additionally, the simulation findings indicated that, within a span of 50 years, the anticipated decline in agricultural output may result in an approximate 30% decrease in average income, in contrast to the potential outcome if climate change were not a factor.

Ozor (2009) employed a descriptive analysis to elucidate the mechanisms underlying climate change, so facilitating a more inclusive comprehension of the idea. The report provides a comprehensive analysis of the effects of climate change on different aspects of national development, including reduced agricultural output, food insecurity, resource disputes, unemployment, environmentally-induced migration, livelihood challenges, and health problems. The study also observed that these consequences arise from the destructive impacts of flooding, drought, erosion, desertification, sea level rise, heat stress, pests and illnesses, and unpredictable rainfall patterns, which are caused by climate change. The report also indicated the necessity of implementing climate policy in Nigeria, establishing the National Climate Change Commission (NCCC), creating a national framework for climate change adaptation, and adopting emerging technology.

Onuoha (2009) examined the risks presented by climate change worldwide, focusing specifically on developing countries. These countries heavily rely on agriculture, which in turn relies on weather and climate conditions. The study employed the sustainable development concept, namely the Green Wall Sahara Nigeria Programme, as a strategy to introduce vegetation in the arid and desert-ridden regions of Northern Nigeria. The study determined that addressing the issues posed by climate change to economic growth and sustainable development in Nigeria necessitates the use of inventive reasoning, comprehensive concepts, groundbreaking remedies, and the active participation of all relevant parties.

Zhai *et al*. (2009) conducted a study to investigate the possible long-term impact of global climate change on agricultural production and trade in the People's Republic of China. The study employed an economy-wide, global computable general equilibrium (CGE) model to analyse the potential impact of climate change on global agricultural productivity until 2080. The findings

indicate that as the agricultural sector's contribution to GDP decreases, the overall macroeconomic effects of climate change are likely to be moderate.

Seo et al. (2009) conducted a study in Sri Lanka to examine the impact of climate change on agricultural productivity. They employed the Ricardian method for their analysis. The model examined the net revenue per hectare for the country's four most significant crops, specifically rice, coconut, rubber, and tea. The study primarily examined the impact of precipitation on crop output, as there is a wider range of precipitation levels across the country. However, the study was only able to conduct a basic analysis of the effects of temperature, as there was a restricted range of temperature fluctuation. The study reveals that an increase in precipitation is projected to have positive effects on all crops examined. The benefits observed ranged from 11% to 122% of the existing net revenue of the crops in the model. Conversely, it was forecasted that the rise in temperature would have detrimental effects on the economy, resulting in a decrease in agricultural productivity ranging from -18% to -50%.

Efe (2009) conducted a study to analyse the potential risks posed by climate change to food security and livelihoods in certain states in Nigeria, whereas Ubachukwu (2005) assessed the impact of climate change on agricultural productivity in the Niger delta. These studies revealed that climate change has a substantial influence on various aspects of crop yields, including the availability of seeds, as well as the access and utilisation of food. The studies observed a correlation between reduced crop yields and declining temperatures in the study locations. Additionally, it was found that a majority of the farmers had a limited understanding of the risks associated with climate change.

Efe (2008) emphasised the consequences of climate change-induced fluctuations on food security and livelihoods. The study suggests that the management concerns identified should be incorporated into the decision-making and policy-making processes by stakeholders to guarantee food security in northern Nigeria. Njoku (2006) observed a declining pattern in the number of wet days per year in Sokoto and Kano, but Kaduna experienced only a little decrease in its annual rainy days. The observed variability in climate change has been demonstrated to adversely impact annual agricultural output. The study additionally discovered that a decline in the availability of food crops coincided with a drop in both rainfall and temperatures in the studied regions.

Odjugo (2005) conducted a study on the impact of climate change on the socio-economic development of Nigeria. The findings revealed that climate change and existing climatic variability will disproportionately affect the low-income and marginalised populations in Nigeria. Furthermore, climate change will hinder efforts to alleviate poverty by negatively impacting economic growth, livelihoods, assets, and increasing the level of risks faced by the population.

Ogbuabor and Egwuchukwu (2017) investigated the influence of climate change on the overall expansion of the Nigerian economy. The OLS estimation technique and data from the period 1981-2014 were utilised. The study utilised annual variations in rainfall, carbon emissions, and forest depletion as indicators of climate change. Additionally, changes in government expenditure, domestic sector investment, and currency rate were included as control variables. The findings suggest that carbon emissions have a negative impact on both long-term and short-term economic growth. Furthermore, the depletion of forests has a detrimental effect on short-term growth. These findings suggest that the Nigerian government should develop and enforce

regulations to reduce carbon emissions and prevent deforestation. Specifically, Nigeria needs to establish a National Climate Change Commission to address all matters related to climate change. Moreover, the discovery that domestic private investment and the exchange rate between the Nigerian naira and the US dollar hinder economic growth in Nigeria implies that policymakers and governments at all levels in Nigeria should develop and enforce policies to counteract these unfavourable consequences.

However, the available literatures reviewed did not include annual average temperature as one of the variables of climate change alongside other economic variables, which is part of the gap the present research filled. Also, the data collected extended to the period of 2020, which no available scholarly literature known to the researchers on this subject have been able to capture, thereby making the present study contribute to the better understanding of the effect of climate change on Nigerian economic sustainability. Therefore, this study is aimed at examining the impact of climate change on Nigerian economic sustainability withina period of 1990 to 2020.

Research Method

This study utilised ex-post facto analysis of a quasi-experimental design, which involved analysing time-series data, to investigate the effects of climate change proxies on Nigerian economic sustainability variables. A secondary source of data was utilised. According to Nwankwo (2013), ex-post facto analysis enables the assessment of the impact of independent variable(s) on a dependent variable, which aligns with the purpose of this study.In this study, Carbon emissions and Annual Average Temperature were adopted as proxies for climate change, while Agriculture and Exchange Rate (from Naira to Dollar) were adopted as measures of economic sustainability. The model specification for the study is stated below;

$GDP = f(CEM, TEMP, AGRIC, EXR)$……(1)

Nigeria's economic sustainability model is stated below in its functional form:

$GDP_t = f(CEM_t, TEMP_t, AGRIC_t, EXR_t$,……(2)

This is further stated in econometric form below:

$GDP_t = \beta_0 + \beta_1 CEM_t + \beta_2 TEMP + \beta_3 AGRIC_t + \beta_4 EXR_t + U_i$……(3)

Where,

GDP = Gross domestic product, expressed in billions of naira (a metric for the total economic activities in the Nigerian economy),

CEM = carbon emissions (metric tons per capita) Nigeria

TEMP = averageannual temperature (measured in ^oC)

AGRIC = agricultural production (Crop production, Forestry, Fishing and Livestock)

EXR = average official exchange rate (naira to dollar)

β_0 = The slope (intercept) of the function

β_1 = coefficient (slope) of carbon emission

β_2 = coefficient (slope) of average temperature

β_3 = Coefficient (slope) of agricultural production

β_4 = Coefficient (slope) of average official exchange rate

u = stochastic term

t = unit of time.

This study utilised the Autoregressive Distributive Lag (ARDL)/bond test approach created by Peseran, Sin, and Smith (2011) due to the presence of variables that integrate at both level (0) and first difference (order I) in the data sets. ARDL was employed to ascertain a durable connection between the variables. Furthermore, ARDL is suitable for analysing small datasets

and may be easily applied using ordinary least squares (OLS). It does not suffer from endogeneity issues and can simultaneously estimate long-run and short-run coefficients, making it applicable for a mix of both I(1) and I(0) stationary variables. Furthermore, in order to prevent the integration of any variables at second order, this study employed the Augmented Dickey Fuller (ADF) test to explicitly examine the stochastic features of each individual series. Furthermore, the ARDL approach is appropriate due to its use of a solitary equation framework, which facilitates its ease of implementation and interpretation.

In addition, a unit root test was used to assess the stationarity properties of the time series data sets used in this study. It is used to ascertain the order of integration of each variable in the model. In order to accomplish this, the researchers utilised the Augmented Dickey Fuller (ADF) test to determine the presence of a unit root. The GDP, agricultural production, and exchange rate statistics were sourced from the 2022 Central Bank of Nigeria Statistical Bulletin, while the carbon emission and average temperature data were sourced from the World Bank Database (2020). The data were recorded and analysed for their time series characteristics, while the model was also evaluated to ensure that the underlying assumptions are sufficiently met.

Result and Discussion

The analysis started by testing the stationarity of the properties of the time series data. The results of the unit root tests are displayed in Table 1 below. The results indicate that all the series showed stationary behaviour at I(1), except for agricultural product, which exhibited stationary behaviour at 1(2). In addition, AGRIC, CEM, EXR, and GDP showed significant results at both the 1% and 5% levels, while TEMP only showed significance at the 5% level. It appears that the variables have successfully passed the co-integrated test. Nevertheless, the stationarity of variables shows a varied outcome when tested at levels and first difference using the Augmented

Dickey-Fuller (ADF) unit root tests. This satisfies the necessary condition for utilising the Autoregressive Distributive Lag (ARDL) method. The bounds tests for co-integration test are utilised to assess the presence of a long-term relationship between the variables employed in the model. Table 2 below presents the results of the model, indicating a significant long-term relationship between the dependent variable (GDP) and the independent variables (AGRIC, CEM, EXR, TEMP). F-Bound test shows that the model has passed co-integration test. This is because; F-statistic value is 41.42930 and is greater than lower (3.47) and upper (4.57) bounds at 5% level of significance respectively.

Table 1: Unit root Test using Augmented Dickey-Fuller Test (ADF)

Variable	T-Statistic	Probability	**Stationarity**
AGRIC	-6.356347	0.0001**(Sig at 1% & 5%)**	I(2) at first diff
CEM	-6.516596	0.0000**(Sig at 1% & 5%)**	I(1) at first diff
EXR	-4.535568	0.0059 **(Sig at 1% & 5%)**	I(1) at first diff
GDP	-4.320448	0.0098 **(Sig at 1% & 5%)**	I(1) at first diff
TEMP	-4.194678	0.0127 **(Sig at 5%)**	I(1) at first diff

Source: Author's computation using Eviews.

Table 2: Bounds Tests for Co-integration

F-Bounds Test			Null Hypothesis: No levels relationship	
Test Statistic	Value	Signif.	I(0)	I(1)
F-statistic	41.42930	10%	3.03	4.06
k	4	5%	3.47	4.57
		2.5%	3.89	5.07
		1%	4.4	5.72

Source: Author's computation using Eviews.

Table 3: ARDL Error Correction Regression

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-4370139.	198164.6	-22.05308	0.0002
@TREND	-12674.95	815.3696	-15.54504	0.0006
D(GDP(-1))	-0.214021	0.071820	-2.979967	0.0586
D(GDP(-2))	1.256289	0.118514	10.60039	0.0018
D(GDP(-3))	0.156102	0.085629	1.823000	0.1658
D(CEM)	18442.96	5124.600	3.598907	0.0368
D(CEM(-1))	47125.47	7726.554	6.099158	0.0089
D(CEM(-2))	-39497.28	5542.750	-7.125935	0.0057
D(AGRIC)	-9.462663	0.848800	-11.14828	0.0015
D(AGRIC(-1))	-15.24805	1.000442	-15.24132	0.0006
D(AGRIC(-2))	-15.75279	1.194582	-13.18687	0.0009
D(EXR)	-55.23247	23.62208	-2.338171	0.1014
D(EXR(-1))	-113.1061	41.26239	-2.741142	0.0713
D(EXR(-2))	142.1067	47.55375	2.988337	0.0582
D(EXR(-3))	414.4565	36.19555	11.45048	0.0014
D(TEMP)	51093.68	3038.255	16.81679	0.0005
D(TEMP(-1))	-54316.60	5410.652	-10.03883	0.0021
D(TEMP(-2))	-36171.44	3678.256	-9.833857	0.0022
D(TEMP(-3))	-29557.44	2456.785	-12.03094	0.0012
CointEq(-1)*	-0.340894	0.015506	-21.98504	0.0002
R-squared	0.998122	Mean dependent var		26970.37
Adjusted R-squared	0.993024	S.D. dependent var		18861.79
S.E. of regression	1575.334	Akaike info criterion		17.69388
Sum squared resid	17371730	Schwarz criterion		18.65376
Log likelihood	-218.8673	Hannan-Quinn criter.		17.97930
F-statistic	195.8052	Durbin-Watson stat		2.999055
Prob(F-statistic)	0.000000			

Source: Author's computation using Eviews.

Table 4: ARDL Long Run Form and Bounds Test

Variable	Coefficient	Std. Error	t-Statistic	Prob.
CEM	-290870.5	119871.4	-2.426523	0.0936

AGRIC	41.35917	7.617853	5.429243	0.0123
EXR	1403.930	784.0622	1.790584	0.1713
TEMP	491215.4	247175.9	1.987311	0.1411

Source: Author's computation using Eviews.

Table 5: Descriptive Statistics of the study Variables (GDP Model)

	GDP	CEM	TEMP	AGRIC	EXR
Mean	248700.9	0.687097	27.29935	9916.021	132.8764
Median	164579.4	0.700000	27.38000	6032.332	129.0000
Maximum	740432.2	0.900000	27.86000	37241.61	381.0000
Minimum	5195.059	0.500000	26.59000	106.6300	8.037800
Std. Dev.	239135.7	0.120394	0.292870	10381.90	101.6692
Skewness	0.668149	0.250465	-0.309109	1.006416	0.736360
Kurtosis	2.074749	1.939585	2.910929	3.093799	2.897173
Jarque-Bera	3.412301	1.776571	0.503915	5.244539	2.815161
Probability	0.181563	0.411360	0.777278	0.072638	0.244735
Sum	7709729.	21.30000	846.2800	307396.7	4119.168
Sum Sq. Dev.	1.72E+12	0.434839	2.573187	3.23E+09	310098.8
Observations	31	31	31	31	31

Source: Author's computation using Eviews.

Table 3 above, which is ARDL error correction regression, indicates that the model passed co-integration test. However, the analysis revealed a remarkably high goodness-of-fit (R-Square) of 0.998. This indicates that the majority of the variations in the dependent variable (GDP) can be attributed to the fluctuations in the independent variables (CEM, AGRIC, EXR, TEMP), with a small portion (0.2%) being accounted for by other factors not included in the model. It suggests that the regressors have sufficiently taken into account the fluctuations in the dependent variable. The annual speed of adjustment is 34%. This indicates that any disequilibrium in the system

takes approximately 34% of the time to return from the short run to the long run. It demonstrates a relatively slow speed of adjustment from the short to long run. With an F-statistic of 195.8052 and a P value of 0.000, the model demonstrates statistical significance at the 1% level. There appears to be a strong correlation between the dependent variable and the independent variables.

After establishing the equilibrium relationship between the variables, we proceeded to estimate the long-run relationship of equation 3. The results can be found in Table 4. The researchers have provided a concise summary of the key findings. In this study, one of the climate change variables has a negative impact on the overall output of Nigeria's economy in the long run. Additionally, both variables have a short-term negative effect on the economic sustainability of Nigeria, as shown in table 3. This suggests that there is need for Nigerian government to either enforce the implementation of already existing policies on carbon emission reduction and other measures, to balance average temperature or formulate more stringent policies that can go a long way in both reducing carbon emissions and stabilizing the atmospheric temperature in the country, especially those coming from the consumption of fossil fuels, gas flaring and transportation (Ucheje *et al*., 2022).

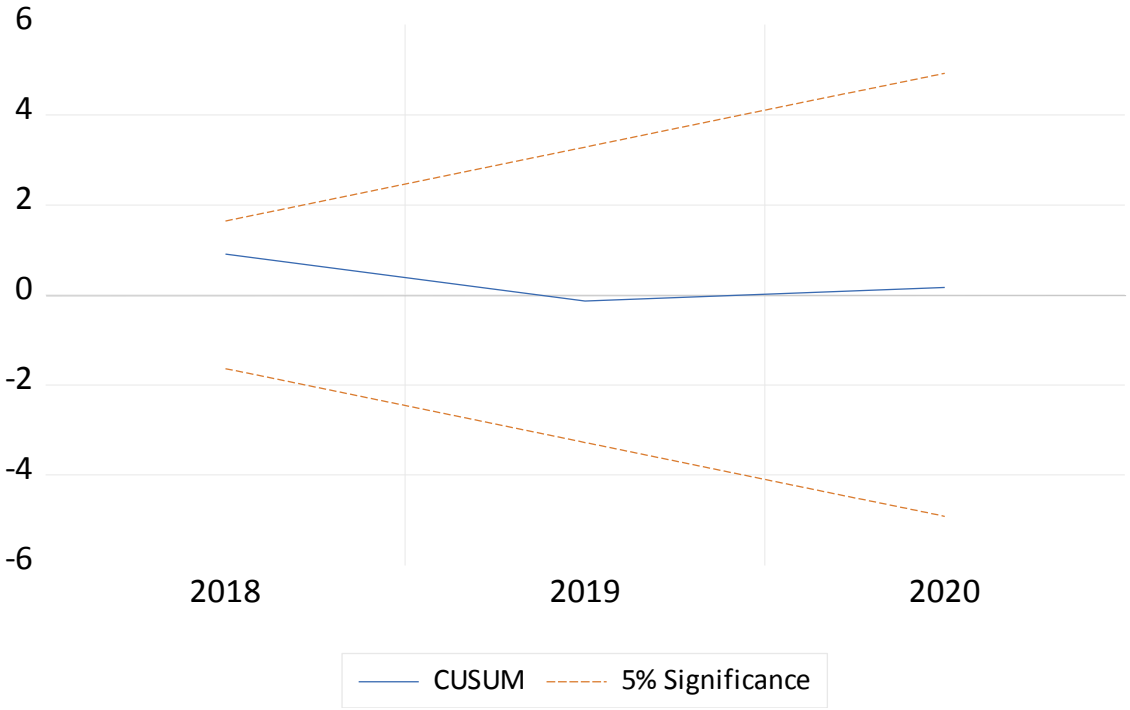
Second, the impacts of average temperature (0.0936) and carbon emission (0.1411) for long run werenot statistically significant at the 5% level, but were significant for short run at 5% level. This shows the level of climate change variables' contribution to Nigeria economic sustainability. Thirdly, the temperature has a positive impact, although it is not statistically significant for long-term relationships. This may be attributed to some regions in Nigeria which have being experiencing unusual rainfall pattern, which have tendency of lowering the average temperature in Nigeria. Therefore, this study strongly supports the ongoing efforts to promote tree planting and forest conservation in Nigeria. Furthermore, among the control variables,

agricultural production aligned with the expected theoretical outcomes, with the exception of the exchange rate. However, the positive value of agricultural production (p=0.0123), favours Nigerian economic sustainability and was statistically significant at 5%, while exchange rate impact positivelyand insignificantly on Nigerian economic sustainability at the 5% level for long run form. This implies that the current exchange rate levels in the economy may not be sufficient to ensure long-term economic sustainability. Nevertheless, both economic variables (AGRIC, EXR) were both statistically significant and contribute positively and negatively respectively to Nigerian economic sustainability at short run relationship. Hence, it meets the theoretical expectations at short run relationship.

From the above table 5, the mean values are 248700.9, 0.687097, 27.29935, 9916.021and 132.8764for GDP, carbon emissions, annual average temperature, agricultural production and exchange rate respectively. From these, the data suggests that agricultural production is the most relative to GDP. The standard deviation showed that carbon emission (CEM) has a smaller spread relative to annual average temperature, agricultural production and exchange rate used in this study, while agricultural production has the largest spread. The standard deviation for GDP stood at 239135.7.The table also shows that agricultural production (AGRIC) had the highest inflow in relation to carbon emission (CEM), annual average temperature (TEMP) and exchange rate (EXR).

The table also shows that the data for all the variables have a positive tail. This is apparent from their skewness coefficients. According to the Jarque-Bera test statistics, it is evident that GDP, CEM, TEMP, and EXR do not follow a normal distribution. However, AGRIC is an exception as it is normally distributed, as indicated by its probability value.

Figure 1: Model (GDP)



From figure 1, the CUSUM test confirms that the model is well stated. As the graph for model show that the blue line did not cross the red line, implying that the model are well stated and stable therefore, can be used for the required analysis.

Conclusion and Implications for Policy

This study investigated the effect of climate change on Nigerian economic sustainability. The research made use of Autoregressive Distributive Lag (ARDL)/bond test approachand OLS estimation technique, while data for the period of 1990-2020 was collected. Climate change was

captured by analysing changes in average atmospheric temperature and carbon emission. To ensure accurate estimation, control variables such as agricultural production and exchange rate were taken into account. The study utilised an error correction model to consider both long-term and short-term relationships. The analysis revealed that carbon emissions have a negative impact on the long-term and short-term economic sustainability of Nigeria. In the short run, the sustainability of the Nigerian economy showed a significant correlation with the average atmospheric temperature. The analysis suggests that it is important for environmental stakeholders and the Nigerian government to work together in developing and implementing policies aimed at reducing carbon emissions and preventing deforestation. Efforts should be made by the government to reduce carbon emissions, particularly those stemming from gas flaring, bush burning, deforestation, fossil fuel consumption, and transportation. Promoting the planting of trees within and around cities is crucial, as it can have a significant impact on carbon sequestration and help maintain a balanced temperature.

Efforts should be made by government towards ensuring that policies (in line with National Climate Change Policy for Nigeria) that are environmentally friendly are made and enforced that can encourage agricultural production at all levels in order to reduce import of agricultural produce, thereby boosting economic growth. Suffice to say that, policies should be developed to encourage production of locally made goods, while considering the use of environmentally friendly technology for such venture. This however, will reduce the high rise in exchange rate (Naira to dollar), thereby encouraging Nigerian economic sustainability.

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