*Sapientia Global Journal of Arts, Humanities and Development Studies (SGOJAHDS), Vol.5 No.3 September, 2022; p.g.209– 223; ISSN: 2695-2319 (Print); ISSN: 2695-2327 (Online)*

# EMPIRICAL ASSESSMENT OF CARBON FOOT PRINT ON THE ECONOMIC GROWTH OF NIGERIA

**SUNDAY OSEIWEH OGBEIDE (PhD)[1];**
**[1] Department of Accounting and Finance, Faculty of Humanities, Social and Management Sciences, Elizade University, Ilara- Mokin, Ondo State, Nigeria. Phone Number: +234-8132490958; Email: sunnyogbeide2017@gmail.com; Orcid: Details: https://orcid.org/0000-0002-2818-7757**

**&**

**SUNDAY NOSA UGBOGBO (PhD, FCA)[2]**
**[2]Department of Accounting, Faculty of Social and Management Sciences, Benson Idahosa University, Benin City, Edo State, Nigeria. Email: sugbogbo@biu.edu.ng**

**ABSTRACT**

*This study investigates the relationship between carbon foot print and economic performance in Nigeria over the period 1980 – 2021. An index of carbon emission intensity, trade openness, human capital investment and electricity consumption were regressed on economic growth, proxy with gross domestic product (GDP).The unit root test was performed on the data using the Augmented Dickey Fuller (ADF). The analysis of the data was done using correlation statistics and the general method of moment (GMM) estimation method. The findings from the study showed that carbon emission has an inverse relationship with economic growth of Nigeria. While electricity consumption, trade openness, and human capital investment exerted positive impact on the economic growth of Nigeria and were not significant, except trade openness. The study concludes that carbon footprints have adverse impact on our environment and the general economy. Following the findings from the study, the study recommends that there is a dire need for both individuals, corporate bodies and the government to take drastic measures to reduce carbon footprint as much as reasonably practicable.*

**Keywords: Economic growth, Carbon Foot Print, Carbon Emission, Climate Change, Greenhouse Gases, Greenhouse Effects.**

## 1.0 Introduction

Researches on carbon foot prints have a great concern for environmental change and economic development. As economic activities increase in a region, country or continent, there is the tendency for carbon emission to increase also. Carbon foot print is a measure of human activities and their effects on the earth's ecosystems resulting in climate change (Gershon & Patricia, 2019).Carbon footprint applies to personal, group and/or sectoral activities in an economy (Aichele, & Felbermayr, 2012; Carbon Trust, 2008; Gareth, 2008). For example, according to the World Health Organization (WHO) (2021) report, about 2.6 billion people around the world still cook with polluting open fires or stoves filled by coal, kerosene and biomass such as crop waste and animal dung, out of which about 3.8 million premature deaths occur from illness like stroke, heart disease, pneumonia and chronic obstructive pulmonary disease (COPD) attributable to household air pollution arising from these inefficient cooking practices.

Carbon footprint is usually made up of different greenhouse gases (Wiedmann, Ercin, Knoblauch, Ewing & Giljum, 2012). Greenhouse gases (GHGs) are any type of gas in the atmosphere that blocks heat from escaping. One of the main sources of carbon footprint and climate change is carbon dioxide, nitrous oxide, and methane. Greenhouse gases (GHGs) often lead to greenhouse effect. Greenhouse effect is the process through which GHGs in the earth's atmosphere trap heat from the sun. Although this is a natural phenomenon that keeps the planet habitable, GHG emissions are causing global warm up at an unnatural rate, thus leading to increasing climate change.

Global warming is caused by the excessive accumulation of greenhouse gases (GHGs) in the atmosphere, the primary source of carbon combustion of fossil fuels for industrial, agricultural and transportation use (Okedina, Lawal, Olayinka & Akinsola, 2021). Global warming is the rapid increase in average surface temperatures on earth caused by the accumulation of greenhouse gases in the atmosphere. It is just one element of climate change. Climate change is a pattern of long-term change in the temperature and weather patterns either globally or regionally. Although these alterations occur naturally, man-made climate change is rapidly accelerating the pace of them.

The global warming potential (GWP) of a greenhouse gas within a given time, indicates the capacity and extent to which greenhouse gases (GHG) contributes directly towards global warming and climate change. Greenhouse gases, especially carbon dioxide (CO2) are emitted in the combustion of hydrocarbon fuels and in other human activities, thereby resulting in greenhouse effect (Gershon & Patricia, 2019). As greenhouse gases (GHGs) mix naturally in the atmosphere, radiations of short waves from the sun are allowed to permeate and absorb energy from the surface of the earth (Akinyemi, Alege, Ajayi, Adediran, &Urhie, 2017).The authors noted that some greenhouse gases(GHGs) are essential for life on earth because they trap atmospheric heat to ensure the planet is warm and in equilibrium. However, this natural process and the earth's thermal equilibrium are disrupted as more greenhouse gases (GHGs) are added to the atmosphere through a combination of natural and anthropogenic activities.
There are two major challenges facing humanity and they include economic development and preserving the environment. However, environment has come to the forefront of contemporary issues for both developed and developing countries since the deterioration of environmental quality raises concerns about global warming and climate change arising mainly from greenhouse gases (GHGs) emissions(Kasman & Duman, 2015; Uddin, Salahuddin, Alam, & Gow, 2017).Carbon footprints drive climate change. There is no doubt that one of the most significant environmental challenges facing the world today is the global impact of climate change. Climate change is commonly referred to the major changes in temperature, rainfall, snow, or wind patterns, usually lasting for decades or even longer (Rahman et al. 2022; Gershon & Patricia, 2019).Climate change can be caused by both human and natural factors (Gershon & Patricia, 2019). Human activities that increase the amount of greenhouse gasses in the atmosphere include burning of fossil fuels, deforestation, farmland development, and cities/roads construction (Gershon & Patricia, 2019). Fossil fuels are made from decomposing plants and animals; they are often found in the earth's crust and contain carbon and hydrogen, which can be burned for energy.

Fossil fuels include coal, petroleum, natural gas, oil shales, bitumens, tar sands, and heavy oils. Because of their origins, fossil fuels have high carbon content. Natural causes include changes in the earth's orbit, the sun's intensity, the circulation of the ocean, and other atmospheric and volcanic activities among others (Gershon & Patricia, 2019).On the average, about 30bn tons of carbon dioxide (CO2) emissions are released annually from human activities accounting for 58.8% of greenhouse gases (GHGs) and this has been confirmed by the Intergovernmental Panel on Climate Change (IPCC) in their Report (Ejemeyovwi, Gershon, & Doyah, 2018; Rahman et al. 2022).Fossil fuels are made from decomposing plants and animals. These fuels are found in the earth's crust and contain carbon and hydrogen, which can be burned for energy. Coal, crude oil, and natural gas are all considered fossil fuels because they are formed from the fossilized, buried remains of plants and animals that lived millions of years ago. Because of their origins, fossil fuels have high carbon content.

The level of carbon foot prints and emissions by individuals, households and corporate organizations varies from one country to the other. In a study undertaken by Gershon and Patricia (2019); Rahman et al. (2022), they reported that the average American emits about 18 tons of CO2 per year and this translates to about 108 tons of CO2 per year for an average family of 6. This number is a whopping 50 tons of CO2 per year per person in Qatar which is about 300 tons of CO2 per year assuming a family size of six (Gershon & Patricia (2019). Australia emits 417.04 million tonnes of carbon foot print yearly, Canada (5.27) billion tonnes, China 571.14 million tonnes, United Kingdom (387.39) million tonnes, India (1.84) million tones and Nigeria 122.78 million tonnes of cabon foot print on a yearly basis (Rahman et al. 2022). The average person on the planet uses about 4 tons of CO2 per year (Gershon & Patricia (2019).

Furthermore, Gershon and Patricia (2019) empirical research analyzed the carbon foot prints for an average family in Nigeria. They reported that the carbon foot print from driving requires burning a gallon of petrol fuel produces which is roughly about 19.64 pounds of carbon dioxide (CO2); the average combined fuel economy of cars and light trucks in Nigeria is 23 miles per gallon. The average vehicle miles traveled per year is 5,000 miles (about 8,000km). This presupposes that the average number of gallons of fuel used per vehicle per year by an individual in Nigeria is about two hundred and seventeen (217). From the foregoing, it can be observed from literature that studies which have dealt with the impact of carbon foot prints on the economic performance of Nigeria is very scanty. This leaves a wide gap for investigation on the empirical fronts.

Therefore, the main objective of this study is to examine the effect of carbon emission on economic growth; investigate the influence of trade openness on economic growth: assess the impact of electricity consumption on economic; and ascertain the effect of human capital investment on the economic growth of Nigeria. Besides the introduction segment, section deals with literature review; section three focuses on methodology, section four concerns the empirical analysis; while section is about conclusion and recommendations.

## 2.0 Literature Review

### 2.1 Conceptual Review

#### 2.1.1 Carbon Foot Print

A measure of the total amount of greenhouse gasses released into the atmosphere as a result of an individual's, organization's, or nation's actions is commonly referred to as carbon foot print. It's usually measured in tonnes of $CO_2e$ (carbon dioxide equivalent).Thus, a person's footprint is the sum of carbon dioxide ($CO_2$) emitted in the course of the production of meals, clothes, housing and transport activities consumed or engaged in by the person or organization per time which could be daily, weekly, monthly or annually (Gershon & Patricia, 2019).Conceptually, carbon footprint relates to the quantity of greenhouse gases (GHGs) emitted in the course of man's daily routine economic activities such as using hydrocarbons for heating, cooling, transportation and electricity generation for lighting, and among others. Greenhouse gases (GHGs) are any type of gas in the atmosphere that blocks heat from escaping. One of the main sources of carbon footprint and climate change is carbon dioxide, nitrous oxide, and methane. Greenhouse gases (GHGs) often lead to greenhouse effect. Greenhouse effect is the process through which GHGs in the earth's atmosphere trap heat from the sun. Although this is a natural phenomenon that keeps the planet habitable, GHG emissions are causing global warm up at an unnatural rate, thus leading to increasing climate change. Global warming is the rapid increase in average surface temperatures on earth caused by the accumulation of greenhouse gases in the atmosphere. It is just one element of climate change. Climate change is a pattern of long-term change in the temperature and weather patterns either globally or regionally. Although these alterations occur naturally, man-made climate change is rapidly accelerating the pace of them.

### 2.2 Environmental Impacts and Measures of Carbon Footprint

The occurrence of carbon footprint creates certain impacts and changes within the immediate environments. Some of the effects normally range from changes in the orbit of the earth, circulation of the ocean, intensity of the sun, volcanic eruptions to other atmospheric and geological activities. As such, there are many approaches to compute carbon footprint (Gershon & Patricia, 2019).Notwithstanding, the universally accepted unit of measuring carbon footprint is tones of $CO_2$ equivalent while GHG emissions are measured in kg $CO_2$ or kg $CO_2e$ (Aichele, & Felbermayr, 2012; Carbon Trust, 2008). $CO_2$ equivalence enables the standard measurement/equalization and summation of different greenhouse gases (GHGs) based on their defined global warming potential (GWP) in relation to $CO_2$ (Gershon & Patricia, 2019). In analyzing a project's carbon footprint, it is necessary to consider all the greenhouse gases (GHGs) emitted directly from the activity and on the site, as well as, the indirect emissions away from the site of the project and along the relevant value chain. For instance, the carbon footprint of a piece of paper used will include greenhouse gases (GHG) emissions from related transportation, electricity generation, manufacturing of the product, food and drinks consumed by the staff during the production, as well as, clothing worn by staff in the paper factory (Akinyemi, et al., 2017).

In the view of Gershon and Patricia (2019), some standards exist for assessing and comparing carbon footprint across products and organizations. Carbon footprint assessment standards are basically ISO 14064, and it is applied in carbon emissions accounting by environment experts, national governments, and International Standard Organization (Gershon & Patricia, 2019). The application of such robust standards has resulted in the promotion of greenhouse gases (GHG) emissions reduction among many people, organizations, governments and institutions (Gershon & Patricia, 2019). British Standards Institution (BSI) and World Business Council for Sustainable Development (WBCSD) have also implemented unique assessment standards. However, uniformity issues persist regarding the application of standard accounting methods in the measurement of greenhouse gases – especially CO2 (Gershon & Patricia, 2019).

A further measure of carbon footprint of households can be approached methodically, taking into consideration both the direct and indirect components of the emissions (Gershon & Patricia, 2019). The direct group emissions are due to activities within the household such as electricity and power generation/consumption, cooking; emissions due to travels by road, sea, and air travels by the family members as a measurement of miles travelled per period as well as emissions from wastes generated directly by the family (Gershon & Patricia, 2019).The indirect components comprise contributions of third parties directly attributable to the services rendered to the particular household such as goods delivery vehicle, emissions at the site of the GENCOs due to electricity generation (Gershon & Patricia, 2019).

**2.3 Carbon Emission and Gross Domestic Product (GDP)**

Climate change is happening more quickly than expected because carbon dioxide levels are rising globally. It is the most pressing challenge of the 21st century and the most severe threat to sustainable development (Rahman et al. 2022). Climate change also harms countries' economies and people's lives. The compounding effects of climate change are hastening its progress, allowing limited time to intervene to avoid catastrophic climate change. Economic development, energy demand, and CO2 emissions are essential study topics. Economic growth is laden with declining in the environment's durability and functioning. The component of environmental management, innovation in pursuit of growth, is too frequently overlooked (Bieth, 2021). To combat declining environmental quality, Shan et al. (2021) proposed enhancing monetary and fiscal policy, reducing non-renewable energy prices, and boosting institutional performance. However, Pejovi et al. (2021) believed that changes in GDP caused most changes in CO2 emissions. Hence, lowering CO2 emissions, in the long-term, may be accomplished by continually growing GDP (Pejovi´c, et al. 2021).

Huang et al. (2021) indicated that HC and financial development have a favorable short- and long-term impact on CO2 emissions. In contrast, renewable energy usage and technological advancements have a negative impact (Huang, Zheng, Li, Meng, Liu, Wang, Zhang, Li, & Guan, 2021). Kerkhof et al. (2009) showed that the typical household in the Netherlands and the United Kingdom emits more CO2than the existing household in Sweden and Norway. Furthermore, in the Netherlands and the United Kingdom, CO2 emissions from HC decrease as income rises (Kerkhof, et al. 2009). On the other hand, Perobelli et al. (2015) found a concession between increased family satisfaction from spending and the increased obstruction in emissions resulting from the household consumption changes. As a result, by tracing the current actions of the Brazilian economy relating to high growth, variations in the economic circumstances, and their consequences on emissions, this study aims to measure the impact on carbon output (Perobelli, Faria &Vale, 2015).

## 2.4 Empirical Review

Chang (2017) examined the linkage between energy use (coal) and economic growth within the BRICS countries in 1985-2009. The study found a unidirectional causality running from energy use to economic growth in China, and from economic growth to energy use in African countries. ANG (2007) applied a co-integration approach to examine the dynamic relationship between economic development, energy consumption and pollution. The study found a short-term unidirectional causality from energy use to economic growth. Omisakin, (2009) tested the EKC hypothesis for CO2 with annual data of CO2 per capita and GDP per capita from 1970-2005. The study found no long-run relationship between carbon emissions per capita and income per capita in Nigeria. The result on the other hand, depicted a U-shaped income-environment relationship rather than an inverted U shaped contradicting the EKC hypothesis. Bello and Abimbola, (2010) found no evidence of an Inverted-U shaped relationship between income and the environment in Nigeria. The study applied time series data from 1980- 2008 in Nigeria. The study concluded that carbon emission in Nigeria is not driven by economic growth but rather driven by financial developments such as foreign direct investment (FDI). This is because the study found that economic development does not have any influence on CO2 emissions in Nigeria. Fodhaet, (2010) investigated the relationship between economic growth and the environmental degradation for a small developing country, Tunisia. The study used a timeseries data from the period 1961-2004 with CO2 and SO2 as the environmental indicators and GDP as the economic indicator. The study results showed that there is a long run co-integration relationship between per capita GDP and the per capita emissions of the two pollutants (CO2 and SO2) but the relationship between CO2 emissions and GDP was found to be more monotonically increasing as compared to that between SO2 and GDP. The study further tested the causal relationship between income and pollution and found that, the relationship between the two in Tunisia is unidirectional both in the short and long run implying that, income causes environmental damages and not vice versa.

Aye and Edojo (2017) investigated the nexus between economic growth and carbon dioxide (CO2) emission using the dynamic panel threshold framework using data from a panel of 31 developing countries. The findings from the study indicate that economic growth has negative effect on CO2 emission in the low growth regime but positive effect in the high growth regime with the marginal effect being higher in the high growth regime. The finding however provides no support for the Environmental Kuznets Curve (EKC) hypothesis; but established a *U*-shaped relationship is established. Energy consumption and population were also found to exert positive and significant effect on CO2 emission. Financial development indicator in the model did not change the conclusion about EKC hypothesis. The employment of panel causality method evidenced a significant causal relationship between CO2 emission, economic growth, energy consumption and financial development. The findings emphasize the need for transformation of low carbon technologies aimed at reducing emissions and sustainable economic growth. This may include energy efficiency and switch away from nonrenewable energy to renewable energy.

Applying the panel unit root tests, panel co-integration methods and panel causality test, Farhani and Rejeb (2012) investigated the relationship between energy consumption, GDP and CO2 emissions for 15 MENA countries using data from 1973–2008. The finding of this study revealed that there is no causal link between GDP and energy consumption; and between CO2 emissions and energy consumption in the short run. However, in the long run, there is a unidirectional causality running from GDP and CO2 emissions to energy consumption.

Saidi and Hammami (2015) analyzed the impact of economic growth and CO2 emissions on energy consumption for a global panel of 58 countries for the period 1990–2012. Similar analysis was conducted for three regional panels, namely, Europe and North Asia, Latin America and Caribbean, and Sub-Saharan, North African and Middle East. The results indicate significant positive impact of CO2 emissions and economic growth on energy consumption for the four global panels. The impact of financial development, capital stock and population on energy consumption were also positive and mostly significant.

Kasman and Duman (2015) employed panel unit root tests, several panel co-integration methods such as the Kao, Pedroni, Westerlund tests specifically, and panel causality tests (panel-based error correction model) to examine the causal relationship between energy consumption, CO2 emissions, economic growth, trade openness and urbanization for a panel of 15 new EU member and candidate countries over the period 1992–2010. Their results provide evidence supporting the EKC hypothesis. The results also indicate that there is a short-run unidirectional panel causality running from energy consumption, trade openness and urbanization to CO2 emissions. The results of the long-run causal relationship showed that carbon dioxide emissions, energy consumption, GDP and trade openness are important in the adjustment process as the system departs from the long-run equilibrium.

Al-mulali,Tang and Ozturk (2015) studied the effect of economic growth, renewable energy consumption and financial development on CO2 emission in 18 Latin America and Caribbean countries for the period1980–2010. The Kao co-integration test results revealed that the variables are co-integrated. Using the fully modified ordinary least square (FMOLS) method, the results indicated an inverted U-shape relationship between CO2 and GDP. Also financial development had a negative long run effect, energy consumption had no long-run effect on CO2. The VECM Granger causality results revealed feedback causality between GDP, electricity consumption from renewable sources, financial development and CO2 in both short-and long-run. Additionally, Granger causality results also revealed that electricity consumption, GDP, and financial development can be a good solution to reduce environmental damage since they have a causal effect on CO2.

Magazzino (2016) investigated the relationship between CO2 emissions, economic growth, and energy use for 10 Middle East countries over the period 1971–2006 using a panel VAR. Both the estimated coefficients and impulse response functions show that for the six GCC countries the response of economic growth to CO2 emissions is negative. CO2 emissions seem to be driven both by its own past values and by energy use. For the other four non-GCC countries, neither CO2 emissions nor energy use seems to have an impact on growth, which is determined by its own lagged values.

The study by Antonakakis, Chatziantoniou and Filis (2017) consider the link between energy consumption per capita growth (and its subcomponents), CO2 emissions per capita growth and real GDP per capita growth using panel VAR. Analysis based on 106 countries classified by different income groups over the period 1971–2011 showed that the effects of the various types of energy consumption on economic growth and emissions are heterogeneous on the various groups of countries. Moreover, causality between total economic growth and energy consumption is bidirectional, thus making a case for the feedback hypothesis. Renewable energy consumption had no significant effect on economic growth and there was no evidence in support of the EKC hypothesis.

Kais and Ben Mbarek (2017) investigated the causal relationship between energy consumption, carbon dioxide($CO_2$) emissions and economic growth for three selected North African countries based on data covering1980–2012. Using a panel co-integration test they found interdependence between energy consumption and economic growth in the long run. Results based on panel Vector Error Correction Model, detect unidirectional relationship from economic growth to energy consumption, a unidirectional causality running from economic growth to $CO_2$ and a unidirectional causal relationship from energy consumption to $CO_2$ emissions. Using data from 1971–2013 on five selected economies of South Asia, Ahmed, Rehman, and Ozturk (2017) explored the relationship between $CO_2$ emission, energy consumption, income, trade openness and population. All the panel co-integration tests (Pedroni- Kao- and Johansen-Fisher panel co-integration) employed confirm that all the variables were co-integrated. Using FMOLS, the results show that energy consumption, trade openness and population increases environmental degradation has negative impact. Further, results indicate that there is uni-directional causality running from energy consumption, trade openness and population to $CO_2$ emission.

Shahbaz, Nasreen, Ahmed, and Hammoudeh (2017) used the Pedroni and Westerlund panel co-integration tests and explored the relationship between trade openness and $CO_2$ emissions while incorporating economic growth as an additional variable. Data from three groups of 105 high; middle and low income countries from 1980–2014 were used. The results show that the three variables were co-integrated. Trade openness hampers environmental quality but the impact varies in the diverse groups of countries. The panel VECM causality results indicate a feedback effect between trade openness and carbon emissions at the global level and the middle income countries but causality runs from trade openness to $CO_2$ emissions for the high income and low income countries.

From the foregoing the results are mixed even for some studies employing similar methodology.

This may be due to differences in the variables included, transformations made, sample period and/or panel of countries studied. It can also be easily observed that most of the studies did not employ general method of moment (GMM) to estimate the data. This constitutes a research gap in the literature.

**3.0 Methodology**

The study is quantitative in nature. It employs the longitudinal research design and time series data from 1980 to 2021. The data were obtained from the World Bank Development Indicators (WBDI) database. Unit root test was performed on the data using the Augmented Dickey Fuller (ADF) and analyzed with the aid of correlation matrix and the ordinary least squares (OLS) multivariate regression estimation method. The model employed in the study is stated in both mathematical and stochastic form as follow:

$Economic\ growth = f(CE,\ ELEC, TOP, HCIVT)$………………….…………………. (1)
$GDP_t = \alpha_0 + \alpha_1 GDP_{t-1} + \quad \alpha_2 CE_t + \alpha_3 ELEC_t + \alpha_4 HCIVT_t + \alpha_5 TOP_t + \varepsilon_{it}$ …….……. (2)
Where:
Economic growth, proxy with gross domestic product; CE represents carbon emission and proxy by $CO_2$ emissions metric tons per capita; TOP represents trade openness and measured as: $\left(TOP = \frac{Total\ import + Total\ Export}{GDP}\right)$; HCIVT represents human capital investment and proxy by government expenditure on primary school children); ELEC represents electricity consumption and proxied by total electricity consumption; $\beta_0$ = Constant (intercept); $\beta_1, \beta_2, \beta_3, \beta_4, \beta_5$, = coefficients; $\varepsilon_t$ represents error term in the regression model; $t$ represents the time period covered by the study.

## 4.0 Empirical Analysis

This sub-section concerns the analysis of the time series data using the correlation statistics and the general method of moment (GMM) estimation method. The unit root test was first performed on the data using the Augmented Dickey Fuller (ADF) technique. The analyses and the results are presented sequentially as follow:

### 4.1 The Unit Root Test

As a standard practice in economic literature, empirical test of macroeconomic data analysis begins with the test of stationarity of variables using the appropriate unit root test procedures. This study employs the Augmented Dickey-Fuller (ADF) test to perform the unit root test in all the series of the model and examine their order of integration. Automatic lag length selection recommended by *E-Views 10* statistical software using a Schwarz Information Criterion (SIC) was used. The advantage of Schwarz Information Criterion (SIC) is that it caters for small number of observations like this study. The results of the ADF unit root test statistics in both level and first difference are presented in Table-1 below:

**Table 1: Unit Root Test Result**

| *Variables* | *ADF Test Statistics at Level* | | *ADF Test Statistics at 1st Difference* | |
|---|---|---|---|---|
| | $t$-ADF | *P- value* | $t$-ADF | *P- value* |
| $GDP$ | - | - | -11.959 | $0.0000*$ |
| $CE$ | -3.452 | 0.001* | -4.7565 | 0.0000* |
| $ELEC$ | - | - | $-8.745$ | $0.0000*$ |
| $TOP$ | - | - | $-8.232$ | 0.0000* |
| $HCIVT$ | - | - | $-20.334$ | 0.0000* |

**Source: Researcher's compilation from E-views 8.00**

The asterisk * P-value shows significance at 5% level. Table 1 shows the ADF statistics unit root tests. At 5 per cent significance level, the results of the ADF unit-root tests provide very strong evidence of stationarity at level 1(0) for carbon emission (CE). But at first difference, gross domestic product (GDP), electricity (energy) consumption (ELEC), trade openness (TOP) and human capital investment (HCIVT) displayed a stationarity result which implied that all the five series were integration at first difference *I (1).*

**Correlation Statistics**

This section presents the Pearson Correlation matrix. The essence of the correlation matrix is to reveal the relationship between variables of interest. The variables could be weak, strong, negative or positively correlated. In addition, it seeks to reveal the multicollinearity between the variables, whether perfect multicollinearity or imperfect multicollinearity. The threshold level of judgment among variables to be highly correlated is 80%. The correlation matrix result is presented in table 2 below:

**Table2: Correlation Matrix Result**

| Variables | GDP | CE | ELEC | TOP | HCIVT |
|---|---|---|---|---|---|
| **GDP** | 1 | | | | |
| **CE** | -0.361 | 1 | | | |
| **ELEC** | 0.298 | -0.626 | 1 | | |
| **TOP** | 0.497 | -0.322 | 0.163 | 1 | |
| **HCIVT** | 0.205 | -0.220 | 0.211 | 0.079 | 1 |

**Source: Researcher's compilation from E-views 8.00**

The correlation matrix in table 4.4 indicates the association between gross domestic product (GDP) and the explanatory variables. The correlation between economic growth (GDP) and carbon emission (CE) is moderate and negatively associated (r = -0.361). This suggests that carbon foot print does not reduce the economic growth of Nigeria in the reference period. The finding is in tandem with the research outcome of Okedina et al (2021); Ang (2007). Gross domestic product (GDP) and electricity consumption (ELEC) have a moderate positive correlation (r = 0.298), an indication that higher consumption of electricity drives economic activities, and by implication the gross domestic product. The relationship between trade openness (TOP) and economic growth (GDP) is strong and positively correlated (r= 0.497). The result affirms the stands of previous literature. The correlation between human capital investment (HCIVT) and economic growth is weak and inversely related (r = -0.205).

**Table 3: Granger Causality Test**

Pairwise Granger Causality Tests
Date: 07/30/22 Time: 16:00
Sample: 1980 2021
Lags: 2

| Null Hypothesis: | Obs | F-Statistic | Prob. |
|---|---|---|---|
| CE does not Granger Cause GDP | 40 | 3.56455 | 0.0390 |
| GDP does not Granger Cause CE | | 0.84981 | 0.4361 |
| ELEC does not Granger Cause GDP | 40 | 1.00305 | 0.3771 |
| GDP does not Granger Cause ELEC | | 1.47882 | 0.2418 |
| TOP does not Granger Cause GDP | 40 | 2.94514 | 0.0657 |
| GDP does not Granger Cause TOP | | 2.39945 | 0.1055 |
| HCIVT does not Granger Cause GDP | 40 | 0.18342 | 0.8332 |
| GDP does not Granger Cause HCIVT | | 0.40993 | 0.6668 |

| | | | |
|---|---|---|---|
| ELEC does not Granger Cause CE | 40 | 1.02785 | 0.3683 |
| CE does not Granger Cause ELEC | | 1.32095 | 0.2799 |
| TOP does not Granger Cause CE | 40 | 0.24717 | 0.7824 |
| CE does not Granger Cause TOP | | 2.61289 | 0.0876 |
| HCIVT does not Granger Cause CE | 40 | 1.11331 | 0.3398 |
| CE does not Granger Cause HCIVT | | 0.28487 | 0.7538 |
| TOP does not Granger Cause ELEC | 40 | 0.78853 | 0.4624 |
| ELEC does not Granger Cause TOP | | 0.01591 | 0.9842 |
| HCIVT does not Granger Cause ELEC | 40 | 1.33991 | 0.2750 |
| ELEC does not Granger Cause HCIVT | | 0.05451 | 0.9470 |
| HCIVT does not Granger Cause TOP | 40 | 1.49770 | 0.2376 |
| TOP does not Granger Cause HCIVT | | 1.42500 | 0.2541 |

**Source: Researcher's compilation from E-views 8.00**

The result of the Granger Causality test in table 3 indicates a unidirectional causality flow from carbon emission with economic growth (gross domestic product).The finding is suggestive that carbon foot print contributes to the economic growth of Nigeria. The finding is in tandem with the research outcome of Okedina et al (2021); Chang (2017); Omisakin (2009).

**Table 4: Analysis of Regression Result**

Dependent Variable: GDP
Method: Generalized Method of Moments
Date: 07/30/22 Time: 16:03
Sample: 1980 2021
Included observations: 42
Linear estimation with 1 weight update
Estimation weighting matrix: HAC (Bartlett kernel, Newey-West fixed
bandwidth = 4.0000)
Standard errors & covariance computed using estimation weighting matrix
Instrument specification: GDP CE ELEC TOP HCIVT
Constant added to instrument list

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| C | 1.173619 | 5.667707 | 0.207071 | 0.8371 |
| CE | -6.633233 | 4.877314 | -1.360018 | 0.1821 |
| ELEC | 0.008318 | 0.025356 | 0.328052 | 0.7447 |
| TOP | 0.157170 | 0.075156 | 2.091242 | 0.0434 |
| HCIVT | 0.000326 | 9.37E-05 | 3.480665 | 0.0013 |

| | | | |
|---|---|---|---|
| R-squared | 0.605046 | Mean dependent var | 3.081190 |
| Adjusted R-squared | 0.529916 | S.D. dependent var | 5.282316 |
| S.E. of regression | 4.635465 | Sum squared resid | 795.0390 |
| Durbin-Watson stat | 1.625181 | J-statistic | 5.775165 |
| Instrument rank | 6 | Prob(J-statistic) | 0.016254 |

**Source: Researcher's Compilation from E-views 8.00**

From table 4, the adjusted R-squared is about 0.529, which represents about 52.9% systematic variation on gross domestic product, leaving the other percentage unaccounted due error term. The finding implies that carbon foot print contributes to the economic growth of Nigeria by 52% in the reference period. The finding is consistent with Okedina et al. (2021). The F-statistics which indicates the goodness of fit of the model is statistically significant in the reference period. The Durbin-Watson statistic of 1.625 portends absence of serial auto correlation in the overall regression result, thus making the finding useful for policy prescription. The empirical findings are in tandem with the researches of Okedina et al. (2021), Rahman et al. (2022) but contrary to the study of Omisakin (2009).

The coefficient of carbon emission (CE) exerts a negative (-6. 632) effect and was not statistically significant. The finding means that carbon emission influences gross domestic product in the Nigeria clime. The study finding is consistent with Mesagan (2015); Ejuvbekpokpo (2014); Omotor (2019); Apergis and Ozturk (2016); Chang (2017); Ang (2009). The finding is however not in tandem with the research of Bello and Abimbola (2017) which concluded that carbon emission in Nigeria is not driven by economic growth but rather driven by financial developments such as foreign direct investment (FDI). This is because the study found that economic development does not have any influence on CO2 emissions in Nigeria. The coefficient of electricity consumption (ELEC) is positive and not statistically significant (0.008) at 5% level. The coefficient of trade openness is positive (0.157) and is statistically significant at 5% level. The finding aligns with the research of Omisakin (2009); Aye and Edojo (2017); Almulatang and Ozturk (2015). The coefficient of trade openness is positive (0.157) is statistically significant on economic growth. The finding is in consonance with the research outcome of Kasman and Duman (2015); Ahmed et.al (2017); Shabaz et al. (2017). The coefficient of human capital development is positive and has no effect (0.000) on the economic growth of Nigeria. The finding may not be unconnected with the poor attitude of the Nigeria government towards the investment in education, from basic to tertiary institutions across the country.

## 5.0 Conclusion and Recommendations

This study examined the nexus between carbon foot print and economic growth in Nigeria. Firstly, the literature examined showed that there are little empirical works that empirically examined the impact of carbon foot print on economic growth particularly in the context of Nigeria. Again, very little attention has been paid to the amount of emissions related to the consumption of products and services and their impact on economic performance in developing country such as Nigeria. This gap necessitated this research. The findings from the study showed that carbon emission has an inverse relationship with economic growth of Nigeria. While electricity consumption, trade openness, and human capital investment exerted positive impact on the economic growth of Nigeria and were not significant, except trade openness. The study concludes that carbon footprints have adverse impact on our environment and the general economy. Following the findings from the study, the study recommends that:

1. There is a dire need for both individuals, corporate bodies and the government to take drastic measures to reduce carbon footprint as much as reasonably practicable.
2. All hands must be on desk to reduce trash output. This is so because landfills and other waste-dump sites emit large volumes of greenhouse gases that pollute the environment.
3. Organizations and corporate bodies are encouraged to go paperless. Although paper can be recycled, the planet will be a lot better if less paper is used.
4. There is need to reduce use of plastic materials. Manufacturing plastics from petroleum resources is a big drain on the finite scarce resources. This contributes significantly to increased pollution of the environment. It is recommended that households opt for greener reusable materials by reducing the amount of wasteful plastics.
5. There is need to encourage forestation. This is so because tree planting is one of the ways greenhouse gases emission can be reduced. The air is purified as plants and trees absorb $CO2$ from the atmosphere. Planting trees, shrubs or a garden grown with different food crops, will reduce overall CO2 footprint.

**References**

Aichele, R. &Felbermayr, G. (2012). Kyoto and the Carbon Footprints of Nations. Journal of Environmental Economics and Management, 63, 336–354.

Akinyemi, O., Alege, P., Ajayi, O., Adediran, O., &Urhie, E. (2017). A Simulation of the Removal of Fuel Subsidy and the Performance of the Agricultural Sector in Nigeria using a Dynamic Computable General Equilibrium Approach Covenant Journal of Business & Social Sciences (CJBSS) 8(1)

Ang, J. B. (2007). CO2 emissions, energy consumption, and output in France. Energy Policy, 35 (10), 4772-4778.

Bieth, R.C. (2021). The influence of Gross Domestic Product and human development index on CO2 emissions. Journal of Physics,1808, 012034

Carbon Trust (2008). Carbon Footprinting: An Introduction for Organizations. http://www.carbontrust.co.uk/publications/publicationdetail.htm?productid=CTV03

Chang, Y. F. (2017). Structural decomposition of industrial CO2 emission in Taiwan: an input-output approach. Energy Policy, 26 (1), 5-12.

Downie, J., & Stubbs, W. (2011). Evaluation of Australian companies‟ scope 3 greenhouse gas emissions assessments. Journal of Cleaner Production. doi:10.1016/ j.jclepro.2011.09.010

Druckman, A. and Jackson, T., (2009) The Carbon Footprint of UK Households 1990-2004: A socio-economically disaggregated, quasi-multi-regional input-output model. Ecological Economics, 2009, vol. 68(7):2066-2077

Econometrica Press (Nov, 2008). What is Carbon Footprint: Briefing Paper. www.ecometrica.co.uk

Ejemeyovwi, J., Gershon, O., & Doyah, T., (2018) Dioxide Emissions and Crop Production: Finding A Sustainable Balance. International Journal of Energy Economics and Policy, 8(4): 303-309.

ESONA, (undated).How to reduce your Family‟s Carbon Footprint.https://www.esonaonline.com/how-to-reduce-your-familys-carbon-footprint/?cv=1 (last assessed 05/06/2019) 3rd International Conference on Science and Sustainable Development (ICSSD 2019) IOP Conf. Series: Journal of Physics: Conf. Series **1299** (2019) 012019 IOP Publishing doi:10.1088/1742-6596/1299/1/012019 13

European Commission, (2007). Carbon Footprint, What It Is and How to Measure It. www.lca.jrc.ec.europa.eu/Carbon_footprint.pdf (last accessed 04.02.19)

Galli, A., Wiedmann, T., Ercin, E., Knoblauch, D., Ewing, B., & Giljum, S. (2012). Integrating Ecological, Carbon and Water Footprint Into a "Footprint Family" of Indicators: Definition and Role in Tracking Human Pressure on the Planet. Ecological Indicators, 16, 100-112

Gershon, O., & Patricia, O. (2019). Carbon (C02) footprint determination: an empirical study of families in Port Harcourt, Journal of Physics, 3(2), 1-13.

Goodall, C. (2007). How to live a low-carbon life: The Individual‟s Guide to Stopping Climate Change. (1st ed.).Oxon: Earthscan.

Haq, G., and Owen, A. (2009). Green Streets: The Neighbourhood Carbon Footprint of York. Stockholm: Stockhom Environment Institute.

Hertwich, E.G. and Peters, G.P. (2009) Carbon Footprint of Nations: A Global, Trade-Linked Analysis. Environmental Science & Technology, 43, 6414-6420

Huang, Q., Zheng, H., Li, J., Meng, J., Liu, Y., Wang, Z., Zhang, N., Li, Y., & Guan, D (2021). Heterogeneity of consumption-based carbon emissions and driving forces in Indian states. Advanced Applied Energy, 4, 100039.

Huijbregts, M.A.J., Hellweg, S., Frischknecht, R., Hungerbu̇hler, K., & Hendriks, A.J. (2008). Ecological footprint accounting in the life cycle assessment of products. Ecological Economics 64, 798-807.

IPCC (2013). "Intergovernmental Panel on Climate Change." Assessment Report AR5 (Retrieved October 10, 2017, from http://www.climatechange2013.org/images/uploads/pachauri14SYRbern.pdf)

IPCC Guidelines for National Greenhouse Gas Inventories (2006)http://www.ipcc-nggip.iges.or.jp/public/2006gl/pdf/2_Volume2/V2_3_Ch3_Mobile_Combustion.pdf

IPPC (Intergovernmental Panel on Climate Change), (2009). IPCC Expert Meeting on the Science of Alternative Metrics. Meeting report, Oslo, Norway.

Kerkhof, A.C., Benders, R.M., & Moll, H. (2009). Determinants of variation in household CO2 emissions between and within countries. Energy Policy **2009**, 37, 1509–1517.

Lam, H.L., Varbanov, P.S., &Klemes, J.J., (2010). Minimizing carbon footprint of regional biomass supply chains. Resources, Conservation and Recycling. 54, 303-309.

Meisterling, K., Samaras, C., &Schweizer, V., (2009). Decisions to reduce greenhouse gases from agriculture and product transport: LCA case study of organic and conventional wheat. Journal of Clean Production 17, 222-230.

Okedina, I.M., Lawal, E.O., Olayinka, I.M., & Akinsola, V.S. (2021). Carbon emissions and economic growth in Nigeria. Hezekiah University Journal of Management & Social Science, 7(1), 129-141.

Pejovi´c, B., Karadži´c, V., Dragaševi´c, Z.., Backovi´c, T., (2021). Economic growth, energy consumption and CO2 emissions in the countries of the European Union and the Western Balkans. Energy Rep. 7, 2775–2783.

Perobelli, F.S., Faria, W.R., Vale, V.D.A. (2015). The increase in Brazilian household income and its impact on CO2 emissions: Evidence for 2003 and 2009 from input–output tables. Energy Economics Journal, 52, 228–239.

Rahman, M.M.; Ahmed, R.; Mashud, A.H.M.; Malik, A.I.; Miah, S.; Abedin, M.Z.(2022). Consumption-based CO2 emissions on sustainable development goals of SAARC Region. Sustainability, 14, 1467.https://doi.org/10.3390/su14031467

Wiedmann, T., & Barrett, J., (2011). A greenhouse gas footprint analysis of UK Central Government, 1990-2008. Environmental Science and Policy 14, 1041-1051

Wiedmann, T., & Minx, J., (2008). A Definition of carbon footprint. Economics Research Trends. Hauppauge: Nova Science Publisher Ch. 1, 1-11. https://www.novapublishers.com/catalog/product_info.php?products_id=5999