Green Finance and Carbon Footprint in Nigeria

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Abstract: **The study examined the effect of green finance on carbon footprint in Nigeria for the period of 2005 to 2023. The specific objectives of the study were to find out if green financing factors such as green bond (GB), green investment (GINV), environmental climate change funds (ECCF) and environmental tax (ENVTAX) minimizes carbon footprint in Nigeria. The fully modified least squares (FMOLS) regression techniques was employed for the analysis of data, and the results revealed that green bond (GB) has significant positive effect on carbon footprint, green investment (GINV) has a weak inverse effect on carbon footprint, while environmental climate change funds (ECCF) has a weak effect on carbon footprint, environmental tax (ENVTAX) is seen to have significant positive relationship with carbon footprint in Nigeria. The study recommends that policymakers should focus on several key areas to enhance environmental and economic sustainability. For instance, issuance of green bond should be given a priority by making them accessible to industrial firms; and must also be closely followed by strict monitoring of the effects of carbon neutrality initiatives, establishing stringent greenhouse gas emission standards, introducing incentive mechanisms to encourage low-carbon actions by firms.**

Keywords: **Green Finance, Green Bond, Green Investment, Carbon Footprint, Statistical and Econometric method.**

1. INTRODUCTION

Carbon footprints is a standard measure of human demands for natural resources, which causes serious depletion of the natural resources by generating wastes for the earth to absorb in the form of GHG emissions in waters, air and on land (Gao, Tian & Meng, 2022). It could also be generated from agricultural activities, energy consumption, transportation, use of water and foods among others. Berners-Lee and Clark (2010) had earlier stressed that "the dominant man-made greenhouse gas responsible for today's climate change or global warming is carbon dioxide (CO_2), which is emitted into the atmosphere whenever fossil fuels are burn in homes, factories or power stations among others. Due to these threats of climate change or global warming on planet earth, the United Nations Environment Programme (UNEP) (2018) has constantly stressed the urgent need for all countries to take deliberate steps to transform the real sector of their economies towards that of low-carbon emissions, which can only be achieved through a well-coordinated deployment of financial resources (sustainable financing) (Yang & Ye, 2024). To this end, the OECD had precisely estimated that about 7 trillion dollars annually will be needed globally to effectively tackle this issues as stated in the Paris Climate Accords by the year 2030. This further provided insight and justification to the relevance of green financing in this regard.

The issue of green financing though not new, but in the last three decades has occupied the front burner of financial and economic literatures globally. The idea is on minimizing the adverse effects of carbon emissions on human and environment by increasing the level of financial flows (from banking, micro-credit, insurance and investment) from the public, private and not-for-profit sectors to sustainable development priorities. A very critical aspect of green financing is to ensure efficient utilization of available resources for environmental and social risks management, cease opportunities that bring both a decent rate of return and environmental benefit, as well as provide enhanced accountability (Lindenberg, 2014). According to Höhne, Khosla, Fekete and Gilbert (2012), Green finance entails financial investments that flows into sustainable development projects and initiatives, environmental products, and policies that encourage the development of a more

sustainable economy; and it includes climate finance but is not limited to it; and it also entails a wider range of other environmental objectives such as minimization of industrial pollution and control, water sanitation, or biodiversity protection. Thus, the whole essence of green financing strategy is the actualization of effective mitigation and adaptation of funds/resources specifically directed at climate change related activities like reduction and avoidance of greenhouse gas emissions (GHGs) and ensuring that such funds are able to minimize vulnerability of goods and persons to the effects of climate change.

Green financing has been strongly advocated in the extant literature as playing a pivotal role in reducing human impact on the environment (Scholtens, 2017); and also has the capacity to provide useful funds through the financial sector of the economy to realize green/human friendly environment (Sachs, 2015). This submission was further corroborated by Li and Jia (2017) when they stated that "environmental financing also known as sustainable financing is the most effective way to reduce environmental degradation; hence, the issue of green finance encourages investment in new technologies and innovations, including renewable energy" (Beohringer, 2015). It has been observed in the empirical literature that a lot of studies on the impact of green finance/sustainable financing on carbon emission or carbon footprint have been carried out in other parts of the globe (Wu, 2018; De-Haas & Popov, 2019; Niu, Zhang & Zhang, 2020; Guo, Wang, Cao &Hou, 2022; Yang & Ye, 2024). However, in spite these, and to the best of the researcher's knowledge, very little has been done in Nigeria in this regard. This created a gap in the literature that this current study intend to fill.

Also, given the report of UNDP (2018) that identified Nigeria as one of the countries, most vulnerable to climate change conditions due to key sectors of the economy such as agriculture and hydropower that are likely to be negatively impacted as rising temperatures and irregular rainfalls disrupt crop and livestock production, as well as reduce the predictability of water flow volumes for power generation, it becomes very imperative to empirically investigate and ascertain the extent to which the various government green finance initiatives and programs have impacted/help in reducing the adverse effects of carbon footprint in Nigeria overtime.

In spite of the 2016 Nigerian Exchange Group (NGX) launching of the green bond market development programme, coupled with the subsequent landmark green bond issuance collaborative effort between NGX, the Debt Management Office (DMO), and the Federal Ministry of Environment, it is still unclear how this initiative have help to minimized the level of carbon emission in Nigeria. The reason being that, the report of the United Nations Office for Outer Space Affairs (UNOOSA) (2023) shows that the country still grapples with an annual deforestation rate of 3.7%, the highest globally. According to the Nigerian Exchange Group (NGX) (2024), between 2002 and 2023, the country lost over 178,000 hectares, amounting to a staggering 95% of tree cover in natural forest areas (Global Forest Watch); this unchecked deforestation, driven by agricultural expansion, logging, and urbanization, has far-reaching consequences, including biodiversity loss, soil erosion, and a significant contribution to global greenhouse gas emissions. This calls for serious empirical investigation, hence, the need for this study.

This paper therefore is structured in such a way that section two contain the literature review, section three is the methodology, section four addresses data analysis and interpretation of results and while section five contains conclusion and recommendations.

2. LITERATURE REVIEW

2.1 Carbon Footprints

Gao, Liu and Wang (2013) defined carbon footprints as a standard measure of human demands for natural resources, which causes serious depletion of the natural resources by generating wastes for the earth to absorb in the form of GHG emissions in waters, air and on land. It was also defined as the total amount of greenhouse gases which including carbon dioxide and methane, that are generated by human activities through the product life cycle (Gui et al., 2019; Obayagbona, 2023). Selin (2024) sees carbon footprint as the amount of carbon dioxide (CO_2) emissions linked with all the activities of a person or other entity like building, corporation, country, among others; and it also includes direct emissions, such as those that result from fossil fuel combustion in manufacturing, heating, and transportation, as well as emissions required to produce the electricity associated with goods and services consumed. It further encompasses emissions of other greenhouse gasses like methane, nitrous oxide as well as chlorofluorocarbons (CFCs).

In a nut-shell, we offer our definition of carbon footprint as the measure of aggregate amount of emissions of greenhouse gases which are trapped and released to the atmosphere in form of heat on daily basis and which ultimately results in climate change and these emissions released to the atmosphere occurs majorly in four dimensions such as emissions from energy

use (like electricity, heating, and cooling), transportation emissions (both personal and public emissions), food emissions (like food production, transportation, and waste emissions), and emissions from waste (such as waste management and landfill methane).

2.2 Green Finance

Green Finance refers to the financing of activities and projects which are into sustainable development projects environmental products and policies which encourage the development of a more sustainable economy (Goyal, 2024). According to Price waterhouse Coopers Consultants (PWC) (2013), green Finance in banking sector refers to financial products and services that incorporate environmental factors into the lending decision-making process, as well as in post-financing monitoring and risk management and these offerings are intended to encourage environmentally responsible investments and support low-carbon technologies, projects, industries, and businesses. In an earlier study by Höhne, Khosla,Fekete and Gilbert (2012), Green finance was defined as that area of finance which focuses on investments in sustainable development projects and initiatives, like environmental related products, as well as specific policies that encourage the development of a more sustainable economy. Hence, encompasses climate financing, larger environmental goals like effective management of industrial pollution, water sanitation, as well as biodiversity conservation.

Therefore, for this study, we define green finance as financial services purely designed to cater for effective reduction of carbon dioxide emissions that endanger human lives globally through the instrumentality of green bonds, green insurance, green securities, green loans, among others. It further involves funding of waste management projects, waste sanitation projects, industry pollution control projects, climate change adaptation projects.

2.3 Green Financing Instruments

Interest, awareness and adoption green Financing among nations of the world is growing steadily by the day because of its ability to provide government and its agents, firms, business organizations and indeed investors the opportunity to effectively drive positive change and contribute to realization of a sustainable economy. To this end, firms can enhance their environmental performance, reduce aggregate carbon dioxide emissions by embracing green projects initiatives that will promote sustainable green economy in the long run. According to Goyal (2024), investors can also benefit from the growing market for green investments, which offer the potential for attractive financial returns while also contributing to positive social and environmental outcomes.

Green Financing are often make through some of the following instruments below.

(i) Green Loan/Lending: This provides affordable loans for environmentally sustainable projects like energy-efficient home renovations to funding solar panel installations for businesses. Under this scheme, lenders offer favourable terms, such as lower interest rates or longer repayment periods. The loans enable borrowers to minimize their carbon emissions thereby promoting a culture of sustainability. When businesses invest in green initiatives, it encourages whole community to follow suit, creating a ripple effect of environmental consciousness.

(ii) Green Equity: This involves investments in shares of listed companies within the environmental protection industry, provides companies with increased financial resources and investor attention; and also encourages companies to become more proactive in environmental protection investments, leading to productivity improvements and reduced carbon emissions (Wu, Liu & Cai, 2024). It covers all forms of environmental protection industry support programs, like government-issued environmental protection industry support policies and initiatives from environmental protection industry associations; which offer valuable support and services to the environmental protection industry, thereby facilitating smoother operations and contributing to the enhancement of carbon emission efficiency (Wu, Liu & Cai, 2024).

Thus, Green equity are of three types such as:

a. Pure-play green companies: These businesses are solely focused on environmental products or services.

b. Green leaders: Established companies with strong sustainability profiles and significant green revenue streams in the market.

c. Green transition companies: Companies which undergo a transformation towards more sustainable business models.

(iii) Green Bonds: Green bonds are a type of fixed-income instrument which are specifically designed to raise capital for projects that have positive environmental or climate-related benefits. The main characteristics of green bonds as stated by Goyal (2024) include but not limited to the followings:

(a) Proceeds Utilization: the proceeds from green bonds are exclusively used to finance projects that have a positive impact on the environment

(b) Transparency: to ensure transparency and accountability, green bond issuers are required to provide details on the use of proceeds and the environmental impacts of the projects financed periodically

(c) Issuers: green bonds are generally issued by a variety of entities, including governments, corporations, and Financial Institutions.

Nevertheless, green bonds posses several benefits, which includes but not limited to the follows:

(a) Supports Sustainable Development: green bonds are issued with similar terms and conditions to conventional bonds, which provides investors with a familiar investment options with the added benefit of supporting sustainable development

(b) Low Carbon Economy: green bonds play a vital role in supporting the transition to a low-carbon economy and mitigating the impacts of climate change

(c) Diversification of Investments: Green bonds also help issuers to diversify their sources of funding and access a pool of investors which are socially responsible.

(iv) Green Insurance: this is a type of coverage that pays for the use of environmentally friendly or more energy-efficient projects, equipment or appliances when making repairs. Any policyholders that is already green, discounts are usually offered on their insurance premiums. According to Zona, Roll and Law (2014), sustainable and green insurance products are those that cover the design, production and use of these sustainable products, or the liability associated with their production and use which also indemnify against the environmental consequence of potential climate change decisions (or indecisions) made by executives in directors and officers coverage, coupled with such policy frameworks that promote sustainable or green behaviour in the long term. There also exist green bond insurance which also work in similar manner like regular bonds but with one main difference. Under this scheme, the funds raised from investors is purely used to fund projects that have a positive environmental impact, like those of renewable energy and green buildings among others. Green insurance policies is very relevant today because of its capacity to reduce aggregate global warming, reduce pollution, and indeed protecting the environment in order for humans to live healthy, happy lives on planet earth; hence, green insurance and bonds initiatives provide a veritable platform for businesses to play their part in actualizing sustainable economy goal through effective reduction of carbon footprints making.

(v) Green Investment: green investments focus on companies or projects committed to the conservation of natural resources, pollution reduction, or other environmentally conscious business practices. Henshaw (2010) sees green investing as a form of socially responsible investing where investments are made in companies that support or provide environmentally friendly products and practices; and these companies usually encourage profit from new technologies that support the transition from carbon dependence to more sustainable alternatives. It also entails 'any structured financial activity that is specially created to ensure a better environmental outcome (Fleming, 2020).

(vi) Environmental Climate Change Funds: The Special Climate Change Fund (SCCF) was established under the Convention in 2001 to finance projects relating to: adaptation; technology transfer and capacity building; energy, transport, industry, agriculture, forestry and waste management; and economic diversification (United Nations Climate Change, 2023).This fund complements other funding mechanisms for the implementation of the Convention. Currently, the largest sources of international public finance for climate mitigation in developing countries are the World Bank-administered Clean Technology Fund (CTF), the Green Climate Fund (GCF) and the Global Environment Facility (GEF).

2.4 Green Finance and Carbon Footprints Nexus

Green financing has the capacity to provide financial assistance to firms or business organizations in order to be able to embrace environmental projects initiatives (Jin, Gao & Wang, 2021). It enables enterprises to upgrade their production machinery and technology, resulting in reduced carbon emissions; and those financial firms that are green in nature are also able to provide technical assistance and managerial expertise, facilitating the execution of environmental protection initiatives (Wu, Liu & Cai, 2024). Hence, green finance can stimulates firms to enhance environmental conservation related investments (Xiong & Sun, 2023). Wu, Liu and Cai (2024) stated that by issuing environmental protection bonds, establishing green funds, and attracting more capital to this sector, green finance can enhance the return on investment for environmental initiatives; and for this reason, firms should increase and enhance investments in environmental protection

initiatives, so that they will be able to effectively minimize carbon emissions and other related costs. Furthermore, green financing can facilitate business transformation and upgrades by mitigating environmental risks; and firms can minimize their carbon footprint by adopting greener manufacturing practices and technology. Institutions that are green oriented can also assist firms to manage environmental risks as well as effective compliance with environmental regulations framework by way of risk management and environmental assessments. Jin, Gao and Wang (2021) added that since there is steady increase in awareness of the relevance of environmental conservation globally, firms and indeed other business organizations can utilize green finance to comply with environmental requirements and avoid pollution-related issues. Therefore, with the presence of green finance, companies are able to have access to funding that are relatively stable and reliable, from where they will be able to constantly prosecute, sponsor and sustain environmental related investments initiatives that will in turn minimize the adverse effect of carbon footprints (Meo & Karim, 2021).

2.5 Theoretical Review

2.5.1 The System Disruption Theory of sustainable finance

The system disruption theory is traceable to Clayton (1995), a Harvard management professor in his 1995 article disruptive technologies: catching the wave. However, in relation to sustainable finance/green finance, it is attributed to the study of Ozili (2021) who further modified the theory in relationship to achieving sustainable finance goal. Accordingly, the system disruption theory of sustainable finance argues that pursuing sustainable finance goals may disrupt the structure of the traditional/mainstream traditional financial system and can disrupt businesses that rely heavily on traditional/mainstream financing. The disruption caused by the transition to sustainable finance, depending on the severity of the disruption, may lead to resistance from affected economic agents or a lack of support for the sustainable finance agenda by affected economic agents. Under this theory, the potential disruption to the existing system (traditional/mainstream finance) arising from the transition to sustainable finance can compel economic agents to make a decision on whether or not to support or join the transition to sustainable finance. Economic agents will base their decision on whether the perceived benefits of sustainable finance outweigh the costs, and whether the resulting disruption will significantly affect their business, income or means of livelihood. However, with the presence of a well disclosed information, investors will be able to decide whether to support the environmental initiative or not. The theory acknowledges that the transition to sustainable finance is not smooth, and can disrupt traditional/mainstream finance; the implication of the theory is that sufficient information should be disclosed about how the transition to sustainable finance will take place, and which systems or structures will be discontinued, if any, in preparation for the transition to sustainable finance (Gutterman, 2020; Ozili 2021).

2.5.2 Priority Theory of Sustainable Finance

This theory is adapted from the work of Ozili (2021, 2023). Accordingly, the priority theory of sustainable finance argues that the rate at which economic agents make every effort to achieve sustainable finance goals in a country or region is a true reflection of the priority given to the sustainable finance agenda in the country or region (Wilson, 2010). According to Ozili (2023), the priority can be assessed from three dimensions: (i) the coordinated, independent and collaborative efforts put together by economic agents towards achieving sustainable finance goals, (ii) how quickly or slowly a consensus is reached, and (iii) how quickly or slowly actions are taken towards achieving sustainable finance goals. Generally, economic agents have different priorities; these priorities can be ranked from the least important to the most important; and the ranking of sustainable finance goals among a list of priorities by economic agents is a true reflection of the importance given to sustainable finance goals by economic agents. However, these priorities may change over time in response to changing realities in a country or in the world. If the sustainable finance agenda is listed among the top priorities of economic agents at a particular time, it means that economic agents will take the sustainable finance agenda very seriously and will put in a great deal of effort to achieve sustainable finance goals (Kuhn, 2020). Conversely, if the sustainable finance agenda is not listed among the top priorities of economic agents, it means that economic agents will not take the sustainable finance agenda very seriously during a given time period and will not put in any significant effort to achieve sustainable finance goals during that period (Krauss, Krüger, & Meyer, 2016).

2.6 Empirical Literature

Ding (2019) examined the impact of green credit financing on environmental degradation and emissions for the period 2007 to 2017. The regression analysis was used for the analysis of data, and the finding indicate that when heavily polluting enterprises face the constraints of green credit financing, it reduces their overall capital allocation, which became insufficient and thereby causes decline in aggregate factor productivity. Zhou et al. (2020) also examined the effect of green finance on carbon footprint in China over the period 2004 to 2020. Employing the panel data analysis technique, the results

showed that green finance has a significant effect on carbon dioxide emissions and is negatively associated with levels of carbon emissions. In the same vein, De-Haas and Popov (2019) examined the effect of structure of carbon financial systems on carbon emissions for several European countries for the period 1990 to 2013. Using the panel data analysis technique, it was found that for equity-funded industries, CO2 emissions per capita are lower compare to others. Also, stock markets invested more funds to less polluting industries, and also push carbon-intensive sectors to develop and implement greener technologies.

Qian et al. (2021) investigated the link between green financing and carbon footprint over the period 2002 to 2019; after employing panel data analysis technique, found that financial development coupled with environmental regulation enhances urban environmental performance without adversely affecting the city's economic performance. This approach also facilitates the transition towards a more environmentally friendly economy. Meo and Karim (2021) investigated how green finance influences carbon dioxide (CO2) emissions in the top ten economies that support green finance (Canada, Denmark, Hong Kong, Japan, New Zealand, Norway, Sweden, Switzerland, the United Kingdom, and the United States). This study uses quantile on quantile regression (QQR), introduced by Simand Zhou (2015), and it was found that green finance had significant inverse effect on CO2 emissions; however, this relationship varies across the different quantiles of the two variables. This variation might be due to green finance market conditions (e.g., bearish or bullish) and country-specific market conditions.

Sun, Zhai, Miao and Sun (2022) examined the effect of green finance on local CO2 emissions of 30 Chinese provincial level cities over the period 2004 to 2019. The study employed a spatial panel Durbin model technique and it was found that green financial development has a significant inhibitory effect on local and neighboring CO2 emissions, which affirms the existence of the ripple effect of green finance. Bai et al. (2022) also examine the impact of green investment and green insurance on green financial growth in China. The outcome of the study indicate that the hypothesized variables significantly and negatively affect carbon dioxide emissions in China over the period of study. The study of Guo, Wang, Cao and Hou (2022) in China on carbon emission reduction and carbon financing in the Yangtze River Economic Belt over the period 2006 to 2019, after using the spatial Durbin and stepwise regression model found that green financing has significant negative effect on carbon emission, but the spillover effect on neighboring provinces were found to be insignificant.

In another similar study, Li et al. (2022) examined how carbon footprints is influenced by green financing in 30 Chinese provinces. Using the entropy value approach, it was found that the connection between green finance and the low-carbon economy is symbiotic in China's eastern and central regions but not in the western region. Lin, Wang, Li and Chen (2023) investigated carbon emission sources in 25 Chinese provinces over the period 2007 to 2020 using the two-stage LMDI method. The results from the analysis indicate that green finance is an effective way to reduce carbon emissions, primarily through its impact on energy structure, energy efficiency, and industrial structure. There are significant non-linear relationships between green finance and the factors affecting carbon emissions, with spatial effects playing a significant role in carbon emissions influenced by energy structure, economic development, energy efficiency, and industrial structure. Hamurcu (2023) examined the relationship between green finance, financial development, carbon emissions and the economies of 26 countries in the world for the period 2018 to 2021 respectively. Employing the panel data analysis, it was observed that CO2 emission had a negative effect on GFI, but GDP had a positive effect on GFI, and the effect of CO2 was greater than GDP. Also, GFI was found to have negative effects on CO2 emissions, and GDP had positive effects on GFI and CO2.

Wu, Liu and Cai (2024) examined the role of green finance in actualizing reduced carbon emissions in China over the period 2006 to 2022. Using the panel data analysis, it was found that green finance significantly contributes to enhancing carbon emission efficiency. The impact of green finance on carbon emission efficiency is subject to a dual threshold effect, which depends on the level of regional economic development. Wu, Wang, Ibrahim and Liu (2024) investigated the effect of green financing on carbon emissions of 30 provinces in China for the period 2011 to 2021 respectively. The panel data analysis was used and the results indicate that green money greatly reduced carbon emissions; and it was also able to reduce this through technological innovation and better industrial structure.

Baştürk (2024) examined the impact of green finance on carbon footprint in 48 countries over the period 2017 to 2022. The GMM was used and the results showed that green finance had significant negative impact on carbon emissions. In like manner, Sadiq, Chau, Ha, Phan, Ngo and Huy (2024) examined the effective of green finance, eco-innovation, renewable energy output (REO), renewable energy consumption (REC), and carbon taxes on carbon dioxide (CO_2) emissions in BRICS

countries over the period 2001 to 2020. Employing the autoregressive distributed lag (CS ARDL) technique, it was discovered that green finance, eco-innovation, REO, REC, carbon taxes and industrialization significantly and negatively impact carbon emissions in BRICS economies overtime.

3. METHODOLOGY

The research design utilized for this study is the expos-fact or the longitudinal research design which entails the use of data in which the researchers cannot manipulate because it has already occurred. The population of the study which is also the sample size is the Nigerian economy, with a particular focus on the green finance-carbon footprint aspect for the period 1996 to 2023. The sampling technique adopted for the study is the census sampling technique where population equals sample size. The data for the study were sourced from the World Bank Data and the Central Bank of Nigeria Statistical Bulletin (2023).

3.1 Theoretical Framework and Model Specification

The theoretical framework for this study is anchored on the priority theory of sustainable finance as enunciated in the work of Ozili (2021, 2023). The theory argues that the rate at which economic agents make every effort to achieve sustainable finance goals in a country or region is a true reflection of the priority given to the sustainable finance agenda in the country or region (Wilson, 2010). Hence, the priority can be assessed from three dimensions: (i) the coordinated, independent and collaborative efforts put together by economic agents towards achieving sustainable finance goals, (ii) how quickly or slowly a consensus is reached, and (iii) how quickly or slowly actions are taken towards achieving sustainable finance goals. It therefore follows that if government, corporate bodies, regulators and indeed, policy makers place priority on minimizing the adverse effect of carbon footprints and environmental degradation, sustainable development as advocated by the UNDP (2018) would be fully achieved. Therefore, priority in the context of this study is taken to be Carbon Finance, Green Bond, Green Investment, Environmental climate change funds and Environmental Tax; and if the government and relevant authorities in Nigeria places priority on these factors, then it will be very easy to drastically reduce aggregate carbon emission in Nigeria.

This study therefore proposed that carbon footprint (measured as Greenhouse Gas Emissions) is taken as the dependent, influenced by Carbon financing instruments such as Green Bond, Green Investment, Environmental climate change funds and Environmental Tax respectively. Therefore, the model can be functionally represented as follows:

GHG = f(GB, GINV, ECCF, ENVTAX)……………………………………………………… 3.1

The econometric form of equation 3.1 is restated as follows:

$GHG_t = \alpha_0 + \alpha_1 GB_t + \alpha_2 GINV_t + \alpha_3 ECCF_t + \alpha_4 ENVTAX_t + u_t$……..……………………….. 3.2

Where:

GHG = Green House Gas Emissions

GB = Green Bond

GINV = Green Investment

ECCF = Environmental Climate Change Funds

ENVTAX = Environmental Tax

u_t = the Error Term

The Appriori expectations are $\alpha_1, \alpha_2, \alpha_3, \alpha_4 < 0$

3.2 Method of Data Analysis

The method employed for the analysis of data for this study is the dynamic least squares (DOLS). The dynamic least squares (DOLS) technique is a simple and efficient approach to estimating the coefficients of a cointegrating relationship. It is an estimator suggested to solve the finite sample bias of OLS caused by endogeneity issue when estimating regression models based on cointegrated variables. It is superior to OLS as it is able to avoid serial correlation, endogeneity and multicollinearity problems by incorporating relevant corrections into the standard OLS model (Stock and Watson, 1993; Masih and Masih, 1996). The advantage of the dynamic least squarestechnique is that, it is not only computationally simpler

but it reduces bias better than FMOLS. The t statistic from DOLS approximates the standard normal density much better than the statistic from OLS or FMOLS.

3.3 Measurement of Variables

The measurements of variables utilized in this study are expressed in Table 3.1 below.

Table 3.1: Definition of Variables

Indicators	Indicators	Index calculation/definition	Source
GHG	Carbon footprint	Aggregate GHG Emissions (inclusive of forest, land use, kt of CO_2 equivalent) etc	Hu et.al (2020); Word Bank Development Indicators (2020)
GB (Green Bond)	Proportion of loans used to finance project	Measured as debt securities designed to finance environmentally friendly projects	Adeleye et al (2022); Atan et al. (2022a)
GINV (Green Investment)	Proportion of investment in environmental pollution	Investment in pollution control/GDP	Lin,et al (2023), Guo et.al. (2022), OECD (2022), IMF (2022)
ECCF	Environmental climate change funds	Climate related disasters frequency, Number of Disasters: Drought	OECD (2022), IMF (2022)
ENVTAX	Environmental Tax	Environmentally Related Tax Revenue; including Taxes on Transport (Excluding Fuel for Transport)	OECD (2022), IMF (2022)

Source: Author's Compilation (2025).

4. DATA ANALYSIS AND INTERPRETATION OF RESULTS

This section focuses on the empirical analysis of data on the impact of blue finance and blue economy using the methods of data analysis earlier stated in section three. These include the unit root test, descriptive statistics, co-integration test and the ordinary least square (OLS) econometric technique.

4.1 Unit Root Analysis

The Augmented Dickey Fuller (ADF) test is employed in order to analyze the unit roots. The results are presented in levels and first difference in Table 4.1. In the result, the ADF test statistic for each of the variables is shown in the second and fifth column, while the 95 percent critical ADF value is shown in the third and sixth column respectively. The result indicates that all the variables are not stationary at level. However, after the first difference was taken, all the variables were now stationary. This implies that the variables are actually difference-stationary, attaining stationarity after the first differences of the variables. Thus, we would accept the hypothesis that the variables possess unit roots; indeed, the variables are integrated of order one (i.e. I[1]).

Table 4.1: Unit Root Tests

Variable	At Levels Panel 1			First Difference Panel 2		
	ADF Test Statistic	95% Critical ADF Value	Remark	ADF Test Statistic	95% Critical ADF Value	Remark
GHG	-0.795264	-3.040391	Non-Stationary	-5.143226	-3.052169	Stationary
GB	2.643059	-3.052169	Non-stationary	-5.372695	-3.052169	Stationary
GINV	-2.850167	3.040391	Non-stationary	-6.014661	-3.052169	Stationary
ECCF	-2.778628	-3.052169	Non-stationary	-4.748912	-3.052169	Stationary
ENVTAX	-1.481987	--3.040391	Non-stationary	-3.989687	-3.065585	Stationary

Source: Author's Computations (2025)

4.2 Cointegration Test

To test for cointegration, we employ Johansen Cointegration Test. The tests is based on two main tests statistic (the eigen value test (λ-max) and the trace test statistics). As can be seen from Table 4.2, the trace test and eigen value test statistics indicate that there are about four (4) significant cointegrating vectors between green finance and carbon footprint in Nigeria.

This implies that a long run relationship exists among the variables. Hence, the results of the cointegration tests are summarized in Table 4.2 below.

Table 4.2: Johansen Cointegration Tests Results.

Null Hypothesis	Trace Test			Maximum Eigenvalue Test		
	Statistic	0.05 Critical Value	Prob. Value	Statistic	0.05 Critical Value	Prob. Value
r = 0*	101.9043	69.81889	0.0000*	63.93636	33.87687	0.0000*
r ≤ 1	37.96789	47.85613	0.0334*	19.07868	27.58434	0.4085
r ≤ 2	18.88922	29.79707	0.5009	11.48902	21.13162	0.5985
r ≤ 3	7.400202	15.49471	0.5316	6.861489	14.26460	0.0557*
r ≤ 4	0.538713	3.841466	0.4630	0.538713	3.841466	0.4630

Source: Author's Compilations (2025).

4.3 The Fully Modified Least Square Regression Analysis

The impact of green finance on carbon footprint in Nigeria is analyzed in Table 4 using the fully modified lest square econometric technique. The result has an impressive goodness of fit information. It is seen that the R squared value of 0.73 is high and it indicates that the explanatory variables in the model effectively predict variations in the dependent variable (GHG) with about 73 percent. Even the adjusted R squared value of 0.65 is equally very high, indicating that the model possessed good predictive ability. Thus, we cannot reject the hypothesis of a significant linear relationship between the dependent variable and all the explanatory variables combined.

With respect to the individual coefficients of the explanatory variables, it is seen that green bond (GB) is rightly signed and in line with the apriori expectation; and it also passed the 5 percent significance level. This means that the used of green bond in Nigeria is a significant determinant of carbon footprint. In other words, as more green bonds are issued, it increases the level of carbon emission, which contradict theoretically expectation as provided by Sachs et al. (2019) and Hafner et al. (2020) that green financial instruments significantly reduce carbon emissions by way of encouraging investments in low-carbon technologies and alternative renewable energies, which further protects the environment and promotes green development. One reason for this result might probably be that green bond is still been treated like the traditional bonds counterpart, and more sincerity has not been put into it especially by some companies that have not fully adjusted their industrial structure to green technologies. This finding further aligns with those of Wu, Liu and Cai (2024) who submitted a significant positive relationship between green bond, green financing and carbon footprint. It however disagreed with the findings of Hamurcu (2023), Baştürk (2024),Wu, Wang, Ibrahim and Liu (2024) who observed that green bond and other green financing options significantly and negatively impact carbon footprint.

The coefficient of green investment (GINV) has a weak negative effect on carbon footprint in Nigeria. This means that GINV does not significantly affect carbon emission reduction. Although, the negative sign suggests that it even has the tendency of reducing carbon emission in Nigeria. Therefore, more deliberate effort is required on the part of government, regulators and policy makers to ensure that the current level of green investment in the country is raised by encouraging companies to invest more in low-carbon technologies and alternative renewable energies. These have the capacity of protecting the environment and promote green development in the long run. As it stands, the number of companies involved in green investment are still very low when compare to those in Europe, Asia and the US. The findings corroborate those of Li et al. (2022), Guo, Wang, Cao and Hou (2022) who found an insignificant negative impact of green investment and green finance on carbon footprint. It however disagreed with the findings of De-Haas and Popov (2019), Bai et al. (2022), Sun, Zhai, Miao and Sun (2022), Lin, Wang, Li and Chen (2023) who found that green investment and green finance significantly reduce carbon emissions.

On the other hands, those of environmental climate change funds (ECCF) has a weak positive relationship with carbon footprint, meaning that ECCF as it stands in the Nigerian context does not in any way influence/reduce the level of carbon footprint. The reason for this weak effect might not be unconnected with the complex financing structures that are needed to share risk in Nigeria (Global Landscape of Climate Finance 2023).This is true because, public and concessional sources in Nigeria today have a larger appetite for this type of project but lack the scale of capital required, hence, are unable to fully fund major projects in this regard.

The coefficient of environmental tax (ENVTAX) is seen to have significant positive effect on carbon footprint in Nigeria. The very essence of environment tax which is also known as green taxes, pollution taxes or eco taxes, are a wide range of legislative charges on businesses and private individuals, aimed at reducing practices which cause damage to the environment. This result might probably be as a result of the current structure of the environmental tax in Nigeria that is weak and not well targeted at those companies with heavy industrial emissions and pollutants. Because, the ultimate goal is not mere revenue generation but drastic reduction in pollution level, as well as a strict deterrent to industrial firms whose activities are detrimental to public health and safety. This finding does not align with those of Sadiqet.al (2024) who found that environmental taxes significantly and negatively impact carbon emissions.

Table 4.3: Green Finance and Carbon Footprint in Nigeria (FMOLS)

Variables	Coefficient	T-Ratio	Prob.
GB	0.119004	2.208525	0.0458*
GINV	-4.78E-10	-0.070894	0.9446
ECCF	20.05389	1.081090	0.2993
ENVTAX	9.21E-10	2.966355	0.0109*
C	85.92558	7.346705	0.0000
$R^2 = 0.73$	$\bar{R}^2 = 0.65$		

Source: Author's Compilations (2025): Note: **sig at 1% level; *sig at 5% level.

4.4 Discussion of Findings

In terms of environmental impact, green finance has been shown to improve air quality (Chen et al., 2021) and plays significant role in reducing carbon emissions by encouraging companies to develop green technologies and adjust industrial structures, which is critical for further improvement of the quality of environment in general. It further corroborated the views of Sachs et al. (2019) and Hafner et al. (2020) that green financial instruments significantly reduce carbon emissions by way of encouraging investments in low-carbon technologies and alternative renewable energies, which further protects the environment and promotes green development. However, with respect to the finding of this study, green investment (GINV) and environmental climate change funds (ECCF) do not seem to align with the above submission as they demonstrated a weak negative and positive relationship with carbon footprint in Nigeria. Therefore, in order to ensure that green financing such as GB, GINV and ECCF reduce the level of carbon emissions in the country, more deliberate effort is required on the part of government, regulators and policy makers to ensure that the current level of green investment, green bond in the country is raised by encouraging companies to invest more in low-carbon technologies and alternative renewable energies. These also have the capacity of protecting the environment and promote green development in the long run. As it stands, the number of companies involved in green investment are still very low when compare to those in Europe, Asia and the US.

Green bond should not be treated like the traditional bonds counterpart; the issuers should be sincerity in its implementation, especially with companies that have not fully adjusted their industrial structure to green technologies. Even the weak effect of environmental climate change funds on carbon footprint are traceable to the complex financing structures required to share risk in Nigeria (Global Landscape of Climate Finance 2023). This make it very difficult for many industrial companies with larger appetite for this type of project to access them because they lack the scale of capital required, hence, are unable to fully fund major projects in this regard. It is hope that the submission of Jiang et al. (2020) that when effectively harnessed, green bond, green credit and green venture capital can mitigate carbon emissions in two broad perspectives such as (i) alleviating green enterprises' financing constraints and providing them with more low-carbon products or services; and (ii) reducing funds for enterprises with high pollution and high emissions appetite/tendencies.

5. CONCLUSION

The study investigated the effect of green finance on carbon footprint in Nigeria over the period 2005 to 2023. The rationale for the study was predicated on the realization that green financing structure/mechanism help to minimized the adverse effect of carbon emissions globally. This was tested in the Nigerian-context using the fully modified least square (FMOLS) regression techniques on times series data such as green bond (GB), green investment (GINV), environmental climate change funds (ECCF) and environmental tax (ENVTAX) in relation to carbon footprint as dependent variable. The results from the analysis indicate that green bond (GB) had significant positive effect on carbon footprint, green investment (GINV) had a weak inverse effect on carbon footprint. While environmental climate change funds (ECCF) had a weak effect on carbon footprint, environmental tax (ENVTAX) is seen to have significant positive relationship with carbon footprint in Nigeria. The study conclude that carbon footprint is positive impacted by green bond and environmental tax in Nigeria.

6. RECOMMENDATIONS

Based on the findings of this study, it is recommended that:

(i) Policymakers should focus on several key areas to enhance environmental and economic sustainability. For instance, issuance of green bond should be given a priority by making them accessible to industrial firms. This must also be closely followed by strict monitoring of the effects of carbon neutrality initiatives, establishing stringent greenhouse gas emission standards, introducing incentive mechanisms to encourage low-carbon actions by firms.

(ii) Deliberate effort is required on the part of government, regulators and policy makers to ensure that the current level of green investment in the country is raised by encouraging companies to invest more in low-carbon technologies and alternative renewable energies. These have the capacity of protecting the environment and promote green development in the long run. As it stands, the number of companies involved in green investment are still very low when compare to those in Europe, Asia and the US.

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DATA:

YEAR	GHG	GB	GINV	ECCF	ENVTAX
2005	103.0522	0	0	0	0
2006	92.8285	0.16	1360162289	0	0
2007	84.5444	0.18	1134474595	0.3127	0
2008	91.9359	0.2	1548443243	0.3546	4.242E+09
2009	81.2606	0.21	1311119538	0.5443	5.342E+09
2010	94.7366	0.24	1939938865	0.5227	6.121E+09
2011	104.4214	0.26	1874226485	0.5480	5.649E+09
2012	102.7996	0.29	1414269233	0.5325	8.789E+09
2013	116.689	0.3	1560156413	0.5200	1.541E+10
2014	123.3099	0.7	2016680331	0.7683	1.257E+10
2015	117.6112	1.5	1467421718	0.6394	1.841E+10
2016	120.6857	3.51	2069035167	0.6009	1.995E+10
2017	119.0181	7.01	1355129486	0.6122	1.995E+10
2018	124.9024	29	1729148110	0.6225	2.396E+10
2019	129.7592	43	2728468863	0.6319	3.027E+10
2020	122.1277	41	2928932557	0.6409	2.839E+10
2021	130.9817	48	2103919097	0.6444	3.027E+10
2022	130.1066	182	1917700766	0.6478	2.839E+10
2023	127.9417	131	2079807819	0.6478	0

Sources: OECD, IMF and World Bank Data (2023)