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Research Article

# Green Finance and Manufacturing Sector Growth in Nigeria: The Role of Globalization

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## Abstract

As more businesses and economies develop more concerns about environmental factors amidst social and governance, thereby shaping the financial flows, green finance had emerged as a critical tool for fostering sustainable manufacturing growth. Green finance had been embraced by developed economies in the achievement of sustainability. Thus, it became imperative for the Nigerian economy to promote sustainability in the manufacturing sector through the issuance, sale, and disbursement of green bonds. This study provided an analysis of how access to environmentally-friendly financial instruments drive manufacturing sector output in Nigeria with emphasis on the moderating role of globalization. The study examined the influence of green finance on the promotion of growth in the Nigerian manufacturing sector with specific focus on the role of globalization in the relationship between green finance and manufacturing sector growth. Data such as the contribution of the manufacturing sector to gross domestic product, government green bonds, corporate green bonds, and trade openness were collected from the Central Bank of Nigeria statistical bulletin and the World Development Index. Through the use of the Generalized Linear Regression (GLM), the study found that government green bonds had positive and significant influence on manufacturing sector growth. However, it was also found that corporate green bonds had negative but significant effect on manufacturing sector growth rate while globalization played negative but significant role in the relationship between green finance and manufacturing sector growth. It was recommended that strict measures at monitoring the green sector market should be enhanced while corporate green bonds should be encouraged in order to boost government's contribution.

## Keywords

Green Finance, Green Bonds, Sustainability, Globalization

## 1. Introduction

The concept of green finance metamorphosed as a result of the need to embrace sustainability. Sustainability involves a cohesive tactical platform which considers environmental concerns while pursuing development in the economy. According to the United Nations (UN), sustainability involves meeting the needs of the present without compromising the ability of future generations to meet their own needs. One of the ways by which developing countries such as Nigeria meet its development needs is through industrialization. Thus, [16] asserted that firms, in the pursuit of their investment decisions, must incorporate green financing, responsible investing, or sustainable investing into their environmental, social and

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governance considerations.

The discussion on green finance is believed to be with a relatively recent history. Green finance instruments were first issued through green bond by the European Investment Bank in 2007 in order to help manufacturing firms to finance their renewable energy projects as well as make those project more efficient [17]. In order to complement the investment decisions introduced by the European Investment Bank, the World Bank in 2008 rolled out its first-ever green bond to support the climate challenge experienced by most economies from the 21st century. Thereafter, other institutions like the African Development Bank (AfDB) introduced its green finance instruments to support and promote environmental sustainability. However, a contradictory proposition on the antecedent of green finance was presented by [14], stating that green credit can be traced first to the Chinese economy. [14] asserted that green credit was first introduced in the 1990s through the People's Bank of China in order to strengthen environmental protection. In order to further promote green credit, in 2007, the China Environmental Protection Administration, People's Bank of China, and China Banking regulatory Commission had a joint policy release which promoted green credit and prevented credit risks.

In the Nigerian economy, however, green finance became a reality, through the advantage of globalization in 2017. According to [1], globalization refers to the process that involves the origins, development, and values of transnational and transcultural combination of human and non-human actions. Thus, with green finance, since it has become a universal activity embraced by all economies in the achievement of sustainability, the Nigerian government became preempted to incorporate it as a yardstick for the achievement of a sustainable economy. Specifically, in December 2017, the Nigerian government issued green bonds, a source of green finance worth ₦10.69 billion [7] These green bonds are distinct from other government bonds because their proceeds are exclusively utilized for the finance and or re-finance of environmentally friendly investments and projects that includes clean and portable water, renewable energy, and other environmentally friendly products. Thus, the Nigerian green bonds represent a form of sustainable finance.

## 1.1. Hypotheses Development

In the Nigerian economy, due to the expansion of the need for green bonds, the Securities and Exchange Commission (SEC) and Nigerian Exchange Group (NGX) respectively rolled out regulations that guide the issuance of green bonds. [18] added that the increasing enthusiasm in the achievement of sustainability, there have been the development of different sustainable finance instruments. Although there have been specific frameworks for the issuance of only green bonds, social bonds, and climate bonds, the Nigerian economy has provided investments in green bonds. Particularly, the Nigerian government became the first in the African continent and fourth globally to issue a sovereign green bond in 2017. The bond was valued ₦10.69 for a five-year period. In 2019, another series of government bond worth ₦17.93 billion was issued while Access Bank Plc issued its first corporate green bonds in 2019 and NSP-SPV PowerCorp Plc issued corporate green bonds in 2022 [9, 1]. The shift into sustainable finance by government and firms in the Nigerian economy has necessitated the introduction of green bonds policy. These regulations are modelled after the Green Bond Principles which is an international set of guidelines that promote integrity in the green bonds market [10] and entrench the support of green bonds in the economy [18].

A study added that significant increase has been seen in the issuance of social bonds in Nigeria [18]. Particularly, in 2021, after the introduction of SEC's policy on social bond, the volume of social bonds traded exceeded 800% when compared to the previous year. Interestingly, these bonds are now traded also in the secondary market through the Nigerian Exchange Group. In accordance to the objectives of sustainable finance, the proceeds from these green bonds' instruments are invested in renewable energy, energy efficiency and optimization, sustainable agriculture, water management. In their study, [2] outlined that the proceeds from the sovereign government green bonds were used to assist renewable energy generation and the reduction of GHG emissions.

In Nigeria, 38.2% of GHG emissions came from the land-use change and forestry sector, followed by the energy, waste, agriculture, and the industrial processes sectors which contributed 32.6%, 14.0%, 13.0%, and 2.1% respectively to GHG emissions. [3] added that the textile, apparel, and footwear subsectors share about 13.76% $CO_2$ emissions while other manufacturing subsectors emit about 30.06% $CO_2$. In another development, the progress of the manufacturing sector in Nigeria since the inception of green bonds have been subjected to different debates. According to [9], green bonds ought to promote the overall corporate performance of firms in the manufacturing sector through the reduction in operating costs, increase in ESG performance, improved goodwill, and promotion of sustainability. However, from the opinion of the [19], the future of the manufacturing sector is unpredictable. As such, the study is aimed at investigating the influence of the introduction of green bonds on the growth of manufacturing sector in Nigeria with specific investigation of the role played by globalization through trade openness metric.

The aim of the study is to examine the role played by globalization in the relationship between green bonds and manufacturing sector growth in Nigeria. Therefore, the following hypotheses are developed to be tested in the study;

H01: The Nigerian government green bonds have no significant and positive influence on the manufacturing sector growth.

HO2: Corporate green bonds have no positive and significant effect on manufacturing sector growth in Nigeria.

HO3: Globalization does not play any significant role in influencing the relationship between green bonds and manu-

facturing sector growth in Nigeria.

### 1.2. Significance of the Study

The findings from this study are significant to the Nigerian government and policymakers who develop green bonds regulations and rules. The results of this study would show to these policymakers that more green finance instruments are to be sufficiently and specifically channeled to the manufacturing sector in order to move with the rest of the world in the achievement of the sustainable development goals in 2030. In addition, the study would provide sufficient knowledge to the management of the different firms in the industry. Indeed, managers in the various firms would pay more attention on sustainable finance investment as it is proven to be an effective tool in reducing pollution and sustain environmental friendliness. Academicians are not left out as the study provides sufficient scholarly knowledge in the field of sustainable finance and investment. Also, farmers, whether in small-scale or large-scale, would find the study needful as insights on the importance of promoting sustainability even from the point of raw-material production is provided.

### 1.3. Scope of the Study

The study is based on the sustainability practices of firms in the manufacturing sector within the period whereby green finance was introduced in Nigeria, that is, 2017 to 2023. Also, the study embraces the role performed by globalization in the achievement of a sustainable economy based on the contribution of green finance to the manufacturing sector.

## 2. Literature Review

### 2.1. Green Finance

Since the development of the concept of green finance, there still have not been an agreed consensus definition. According to [6], one of the major reasons why there has not been an agreed definition for the concept is because many publications have not tried to give it a definition. In order to buttress this assertion, the [20] and [21] did not provide any definition of the concept. In addition to the reasons, the scholars who provide definition have significant variants. In the study of [22], green finance includes financial investments that flows into projects and initiatives that promote sustainability. This includes investments that promote climate finance, reduction in industrial pollution, promotes water sanitation, and protects biodiversity. In their own opinion, [23] considered the concept as green investment. However, [24] limits the definition to the banking sector. Green finance is defined by the products and services of banking firms that promotes environmental investment, stimulate low-carbon technologies for firms.

Green finance comprises of investment in three different aspects which include public investment, private investment, and components of the financial system. First, it involves the financing of public and private green investments in environmental goods and services that include water management as well as the prevention of environmental damages to the climate. Green finance also involves the financing of public policies that are aimed at reducing the operational costs as well as encourage the implementation of the environment. In addition, green finance includes that component of the financial system that specifically acknowledges green investments which include green climate funds or financial instruments for green investments, including specific legal, economic, and institutional framework conditions [6].

### 2.2. Green Bonds

Green bond is an example of instruments used in green financing and investments. According to [7], green bonds are fixed income debt instruments, including private placement, securitization, covered bond, and sukuk, as well as labeled green loans that are in conformity with the Green Bond Principles (GBP) or Green Loan Principles (GLP). [26] explained that the difference between green bonds and conventional bond instruments is in the usage of the proceeds. In addition, green bonds can be used as an asset-backed security which are connected to projects that promote the green economy. The International Capital Market Association (ICMA) [25] looked at green bonds as any debt instrument whose proceeds are particularly meant and applied to finance or re-finance new or existing green investments, either wholly or partly, and which yields sustainable benefits to the environment or promotes green growth.

### 2.3. Globalization

Globalization has been defined differently by various authors depending on their views and perspectives about its importance and function. However, some scholars believe that globalization cannot be done while others claim that its general overview would be constrained by any definition [1]. According to the [5], the concept can be explained as the process of world shrinkage, of distances getting shorter, and things moving closer. In their own view, [1] explained that globalization involves a process that explains the causes, course, and consequences of transnational and transcultural integration of both human and non-human activities.

The significance of globalization is very wide. With globalization, financial systems have been harmonized and communication among capital market participants have been harmonized and improved as business awareness and opportunities have been reachable and achievable. Also, globalization has resulted into improved access to new investment opportunities such as green finance investment and also shortened the investment distance among various markets. In the position of [13], globalization has fostered environmental

protection and the achievement of the United Nations SDGs. In addition, [14] asserted that globalization has improved foreign trade and positively impacted the diversification of exports, especially on renewable energy use among firms in different sectors.

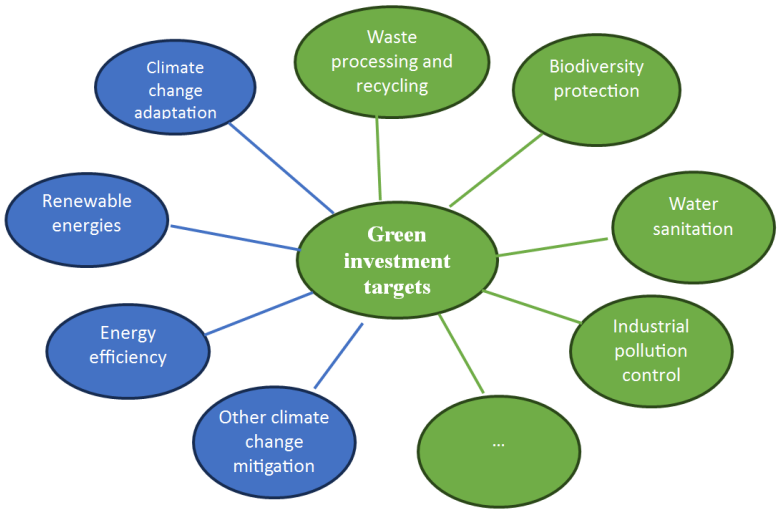



***Figure 1.*** *Diversifications of Green Investments.*

## 2.4. Theories of Globalization

There are a number of theories that explain the need and significance of globalization. These theories include but not limited to the world-system, cultural globalization, neoliberalism and global capitalism, hyper-globalization, transformationalist, dependency, and global governance theories. The world-system theory of globalization was propounded by [27, 28]. The theory suggests that all individual national economies are deeply interconnected, especially through the flow of labour and resources from the periphery to the core. Specifically, the theory divides the global economy into three subsectors of core, semi-periphery, and periphery under the structure of division of labour, political power, and economic influence [12]. According to [29], the implication of the theory is that with globalization, core countries are better off from international trade while periphery economies are often challenged thereby leading to the reinforcement of existing inequalities.

The cultural globalization theory as propounded by Appadurai and Robertson [30, 31] places more emphasis on the distribution and interaction of cultures across the world through media, communication technologies, and migration. [32] explains that with cultural globalization, cultural homogenization is harmonized. The study is hinged on the hyper-globalization theory as introduced by Ohmae and Friedman [34] suggests that the world is increasingly becoming a borderless global village with increasing economic integration, leading to the convergence of economic policies and practices worldwide. Such economic practices include green financing and its policies. The theory, according to [33], the hyper-globalization theory emphasizes the role of multinational corporations in breaking national barriers to investment. Thus, with hyper-globalization, green financing securities can be bought and sold by any investor, irrespective of his nationality, thereby promoting both foreign portfolio investments as well as foreign direct investments.

## 2.5. Empirical Review

There have been different studies on green finance and its importance in achieving sustainability from different economies. In the Chinese economy, [8] confirmed the relationship between investments through green finance and the growth of the economy using panel data from the Chinese provincial. Through the Hamilton optimization theory model, Cobb-Douglas production function, and simulation analysis, it was confirmed that green finance policy is a potent and significant tool that can assist in improving the scale and quality of economic growth in China. It was also found that policies aimed at promoting green finance are significant in increasing the country's capital flow, especially to high-tech industries. In addition, the study confirmed that innovation capital is a significant mediating factor in the effectiveness of green finance on economic growth in China.

Also in the Chinese economy, [14] considered the effects of green finance policy on the efficiency of green innovation in the manufacturing industry. The study had a temporal scope that ranged between 2005 and 2019 using the difference-in-difference model. The study showed that greenhouse policies helped in reducing green innovation efficiency of heavy-polluting industries when compared with the non-heavy polluting industries. In a similar study in the Chi-

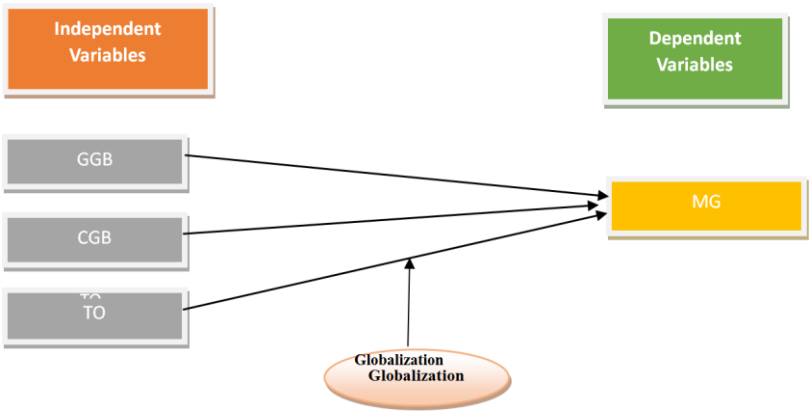
nese economy, [15] examined the impact of green finance in achieving sustainable development. The period of the study was between 2008 and 2020 and data were analyzed using the gray correlation method as well as the GMM model. It was found that there is a positive and strong correlation between green finance and the development of firms in the industrial sector of the Chinese economy. [4] also looked at the Chinese economy when considering the role of green technological innovation and green finance in the improvement of green total factor productivity. The study employed variables such as green finance, financial development, and green technology innovation in 28 Chinese provinces on green total factor productivity between 2011 and 2021. Through the regression analysis, it was discovered that green finance improves the degree of green productivity and that financial development as well as technological innovations had significant and positive influence on green productivity.

Away from the Chines economy, [3] investigated the drivers of carbon emissions in the Nigerian manufacturing sector using a temporal scope between 2010 and 2020. Through sensitivity analysis, it was confirmed that energy intensity and equity-funded production were significant factors that impact increased carbon emissions. However, capacity utilization reduced carbon emissions. Also in the Nigerian economy, [7] considered how green bonds can be effective in achieving sustainable development in Nigeria through green buildings. It was found that green bonds are vital and significant investment instruments that drives the achievement of sustainable green building practices in Nigeria.

Reports from three important institutions regarding green finance investigated how emerging African markets can promote sustainability in the power, transport, and agri-business sectors through green financing. These institutions include Environmental Finance, International Finance Corporation of the World Bank Group and HSBC Global Asset Management in 2021 exemplified five different African countries such as Egypt, Morocco, Ghana, Nigeria, and South Africa. The proposition of the study was that there is a high potential for sustainable green bonds finance in the power, agribusiness, and transport sector despite the challenges surrounding the green bonds market. Furthermore, but in the OECD countries, [11] examined the role of globalization and human capital in explaining the nexus between green finance and green growth between 1990 and 2021. The panel data extracted for the study was analyzed using data such as green growth, green finance, globalization, human capital, and economic growth for 19 OECD countries. The result showed that green finance significantly improves green growth and that human capital positively and significantly relates with green growth. However, with increase in globalization and GDP, green growth is negatively impacted.

## 3. Materials and Methods

### 3.1. Research Design




Source: Researcher's Compilation.

***Figure 2.*** *Theoretical Framework.*

The study's framework integrates notions, theories, and concepts from earlier studies to offer a conceptual foundation for analyzing and interpreting the significance found in the research [35]. The study is built on the hyper-globalization theory and the theoretical framework is built on this theory. Figure 2 displays the relationship among the variables. The major research technique for this study is quantitative in nature, thus, the philosophy that best soothes this study is positivism. Thus, the researcher is focused on collecting and interpreting data objectively and does not include any element of bias or self-interest. The research design is descriptive survey research design because it provides the researcher with

better background information on the evaluation and findings of this study. For this study, secondary data related to government green bonds, corporate green bonds, and trade openness metric for the study's period were employed.

### 3.2. Model Specification

$$MG_t = \beta_0 + \beta_1 LogGGB_t + \beta_2 LogCGB_t + \beta_3 LogTO_t + \beta_4 LogGGB.CGB.TO_t + \mu_t$$

MG measures manufacturing sector growth rate which is estimated as the rate of change in manufacturing sector output over a period of time. GGB is government green bonds which is extracted from the WDI while CGB is corporate green bonds which is extracted from the CBN statistical bulletin. Trade Openness is represented in the model as TO and it is estimated as the sum of exports and imports relative to GDP and gotten from the CBN statistical bulletin.

In the view of [36], modelling the interaction effects of a moderator could either decrease or increase the effects of the independent variables on the dependent variable. An essential component of moderation is determining the causal link for varying amounts of the moderator variable (M) between the independent variable (X) and the dependent variable (Y).

Both the descriptive and inferential statistical techniques are employed in this study. The descriptive statistics involves measures of central tendencies. The measures of dispersions include range, standard deviation, skewness, and kurtosis. Also, taking the form of time series data, stationarity as well as co-integration tests were conducted. The Generalized Linear Regression (GLM) was employed because the data sample is small and they do not conform to the Gaussian expectations and assumptions.

## 4. Discussion and Conclusions

The analysis commences with the description of the variables. The result of the measure of central tendencies and dispersion as displayed in Table 1 shows that the average growth rate in the manufacturing sector since the inception of the government sovereign green bonds is 18.12% with a maximum growth of 29.81% and 6.70% on the minimum. This confirms that with green bonds, the manufacturing sector has witnessed at least 6.70% growth over the years. This growth rate does not exceed the expectations in the economy as the standard deviation was valued at 8.45%, a value lesser than the average value which depicts less volatility in growth rate. Government green bonds a maximum value of 15 billion while it was averaged at ₦3.67 billion and a volatile deviation of 6.39 billion. On the other hand, corporate green bonds had an average value of 5.34 billion, maximum value at 22.4 billion, positively skewed, and with standard deviation of 9.37 billion.

The study also measured the averages of the coupon rate at which those green bonds were issued. The result showed that average interest rate on these coupons was 11.29% while maximum rate was 13.48% and minimal at 9.49%. This shows attractiveness in investment as investors could be enticed by the handsome rate of interest to increase investment in green securities. Lastly, trade openness was averaged at 24.93%, maximum at 27.98% and smallest at 21.75%. This further implies that the Nigerian economy has improved in its trade relation since the period of green finance commenced. Thus, the significance of this increased globalization would further be observed.

***Table 1.*** *Summary of Descriptive Statistics.*

| | MG | GGB | CGB | INT | TO |
|---|---|---|---|---|---|
| Mean | 0.181256 | 3.670000 | 5.342857 | 11.29357 | 0.249322 |
| Maximum | 0.298087 | 15.00000 | 22.40000 | 13.48000 | 0.279872 |
| Minimum | 0.066999 | 0.000000 | 0.000000 | 9.490000 | 0.217515 |
| Std. Dev. | 0.084477 | 6.390016 | 9.371385 | 1.680386 | 0.024801 |
| Skewness | 0.195001 | 1.071637 | 1.115693 | 0.317600 | -0.229517 |
| Kurtosis | 1.727358 | 2.310810 | 2.456040 | 1.648849 | 1.636865 |

Source: Authors' Computation.

### 4.1. Correlation Matrix

The correlation coefficient measured the direction and strength of the relationship between the dependent and independent variables employed in the study. In Table 2, a summary of the correlation coefficients with their corresponding probability values is presented. It could be observed that government green bonds and trade openness had positive relationship with growth in the manufacturing sector while corporate government bonds and coupon rate negatively related with manufacturing sector growth. These relationships

are not significant at the study's 5% level of significance. Also, the strengths of the relationship between government green bonds, coupon rate, and manufacturing growth rate are weak while corporate green bonds and trade openness show relatively strong associationship. While corporate green bonds and trade openness showed 24.42% and 13.02% positive connections with manufacturing sector growth, coupon rate was found to be negative with a coefficient of 5.71%. Furthermore, there is a negative and average relationship between coupon rate and corporate green bonds with a coefficient of -26.70% while a strong, positive, but not significant relationship exists between trade openness and corporate green bonds. Coupon rate was equally found to be negatively and weakly related with trade openness.

*Table 2. Summary of Correlation Matrix.*

| **Covariance Analysis: Ordinary** | | | | | |
|---|---|---|---|---|---|
| **Correlation** | | | | | |
| **Probability** | **MG** | **GGB** | **CGB** | **INT** | **TO** |
| MG | 1.000000 | | | | |
| | ----- | | | | |
| GGB | 0.340908 | 1.000000 | | | |
| | 0.4543 | ----- | | | |
| CGB | -0.169875 | 0.244203 | 1.000000 | | |
| | 0.7158 | 0.5977 | ----- | | |
| INT | -0.371611 | -0.057130 | -0.267021 | 1.000000 | |
| | 0.4118 | 0.9032 | 0.5627 | ----- | |
| TO | 0.212192 | 0.130164 | 0.704739 | -0.208100 | 1.000000 |
| | 0.6478 | 0.7809 | 0.0770 | 0.6543 | ----- |

Source: Authors' Computation.

## 4.2. Unit Root Tests

The peculiarity of time series data calls for the examination of the stationarity pattern of the variables. Therefore, using the Augmented Dickey Fuller unit root test, the result of the shows a mixture of stationarity between level and first difference. Thus, in Table 3, a summary of the ADF unit root result was presented.

*Table 3. Result of ADF Unit Root Test.*

| **Var** | **Level** | | | **First Difference** | | | **Stationarity** |
|---|---|---|---|---|---|---|---|
| | **t-test** | **Cri-val** | **Prob** | **t-test** | **Cri-val** | **Prob** | |
| MG | -2.70 | -3.52 | 0.1258 | -4.08 | -3.69 | 0.0353 | I (1) |
| GGB | -2.98 | -3.52 | 0.0911 | -4.82 | -3.98 | 0.0020 | I (1) |
| CGB | -5.44 | -3.69 | 0.0113 | - | - | - | I (0) |
| INT | -6.07 | -3.69 | 0.0072 | - | - | - | I (0) |
| TO | -3.89 | -3.69 | 0.0417 | - | - | - | I (0) |

Source: Author's Computation.

### 4.3. Regression Results

In order to validate the proposition of the study's objectives, the Generalized Linear Regression model was employed because the data period is small and dataset do not follow the assumptions of Gaussian. Thus, in Table 4, a summary of the GLM regression was presented.

The results shows that government green bond influences growth in the manufacturing sector positively with a coefficient of 0.017502 which implies 1.75% positive change would be witnessed with a percentage change in the issuance of government green bonds in Nigeria. On whether or not the relationship is significant, the study attest by stating that there is a significant and positive effect of government green bonds on manufacturing sector growth. However, unlike the government green bonds, corporate green bonds have been seen to influence manufacturing sector growth negatively and significantly such that a percentage increase in corporate green bonds would propel about 1.33% reduction in manufacturing growth rate.

Coupon serves as the interest paid to bondholders by the bond issuers. The regression result shows that coupon as measured by interest influences growth in the manufacturing sector positively and significantly with coefficient of 0.053 which implies 5.3% growth rate in manufacturing sector output should coupon rate increases by 1%. The moderating variable, that is, trade openness, is seen to possess a negative impact on manufacturing sector growth and productivity. The result specifically asserts that globalization would make manufacturing sector decline in growth through an increase in the country's exports and imports in relative to GDP.

***Table 4.*** *GLM Regression Output.*

| **Dependent Variable: D (MG) Method: Generalized Linear Model (Newton-Raphson / Marquardt steps)** | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Std. Error** | **z-Statistic** | **Prob.** |
| D (GGB) | 0.017502 | 0.003404 | 5.142197 | 0.0000 |
| CGB | -0.013340 | 0.002745 | -4.860132 | 0.0000 |
| INT | 0.053010 | 0.021886 | 2.422090 | 0.0154 |
| TO | -1.815383 | 0.947730 | -1.915507 | 0.0554 |
| Mean dependent var | 0.003350 | S.D. dependent var | | 0.142023 |
| Sum squared resid | 0.004594 | Log likelihood | | 11.71451 |
| Akaike info criterion | -2.571504 | Schwarz criterion | | -2.710331 |
| Hannan-Quinn criter. | -3.127240 | Deviance | | 0.004594 |
| Deviance statistic | 0.002297 | Pearson SSR | | 0.004594 |
| Pearson statistic | 0.002297 | Dispersion | | 0.002297 |

Source: Authors' Computation.

## 5. Discussion

Thus, on the role of globalization in assisting the relationship between green finance and manufacturing sector growth, the study found that globalization is a pest to the overall growth in the manufacturing sector. Trade significant is not just negative but also not significant. It therefore, implies that Nigerian foreign trade activities have not been channeled towards green investment. This result is significantly different from the findings of [8, 14, 4, 15]. The significance and positive influence of government green bonds on manufacturing sector growth can be linked towards the sincerity of government purpose for which the green bonds were issued. This result conforms to the findings of [7, 3].

## 6. Conclusion and Recommendations

The period of industrial revolution has come and gone and many manufacturing firms are moving towards Industry 5.0 which embraces sustainability and sustainable practices. Government plays critical role in actualizing green economy in Nigeria and with the trading of green bonds in Nigeria, achieving sustainable development goals set by the United Nations is evident. The study concludes that globalization, so far, plays negative and not significant role in influencing the relationship between green finance and manufacturing sector growth in Nigeria. As a result, it is recommended that Nige-

ria's trade activities with the rest of the world should be majorly channeled at sustainable practices. Also, issuers of corporate green bonds in Nigeria should be increased. The few players in the market might be the cause of the negative impact on manufacturing sector growth as competition is not enforced in that respect. Government should also endeavour to ensure strict monitoring of the proceeds from green finance and objectively assign the funds for green projects while improvement should be made in the rate of interest as it would attract more investors into green financing.

## Abbreviations

| | |
|---|---|
| GDP | Gross Domestic Product |
| WDI | World Development Index |
| UN | United Nations |
| AfDB | African Development Bank |
| SEC | Securities and Exchange Commission |
| NGX | Nigerian Exchange Group |
| TNP | The New Practice |
| GHG | Globally Harmonized Gas |
| ESG | Environmental, Social, and Governance |
| PwC | PriceWaterouse Coopers |
| GBP | Green Bonds Principles |
| GLP | Green Loan Principles |
| ICMA | International Capital Market Association |
| SDGs | Sustainable Development Goals |
| HSBC | Hongkong Shanghai Banking Corporation Limited |
| OECD | Organization for Economic Cooperation and Development |

## Author Contributions

**Paul Obogo Ushie:** Conceptualization, Formal analysis, Funding acquisition, Writing-original draft.

**Adeniyi James Demehin:** Data curation, Methodology.

**Toyin Waliu Otapo:** Validation, Supervision, Resources, Writing-review & editing.

**Funso David Dare:** Software, Investigation, Project administration.

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This study is not supported by any external funding.

## Data Availability Statement

The data supporting the outcome of this research work had been reported in this manuscript.

## Conflicts of Interest

The authors declare no conflicts of interest.

## Appendix

i. Data used.

***Table A1.*** *Data Employed for Analysis.*

| Year | MG | GGB | CGB | Int | TO | Med |
|---|---|---|---|---|---|---|
| 2017 | 0.120609 | 10.69 | 0 | 13.48 | 0.218033881 | 0 |
| 2018 | 0.215141 | 0 | 0 | 13.48 | 0.25170846 | 0 |
| 2019 | 0.298087 | 15 | 15 | 9.49 | 0.279872162 | 62.97124 |
| 2020 | 0.15219 | 0 | 0 | 9.49 | 0.217515096 | 0 |
| 2021 | 0.275056 | 0 | 0 | 10.365 | 0.242952656 | 0 |
| 2022 | 0.066999 | 0 | 22.4 | 11.375 | 0.272738838 | 0 |
| 2023 | 0.14071 | 0 | 0 | 11.375 | 0.262436352 | 0 |

ii. Descriptive Statistics.

***Table A2.*** *Descriptive Statistics Result.*

| | MG | GGB | CGB | INT | TO |
|---|---|---|---|---|---|
| Mean | 0.181256 | 3.670000 | 5.342857 | 11.29357 | 0.249322 |
| Median | 0.152190 | 0.000000 | 0.000000 | 11.37500 | 0.251708 |
| Maximum | 0.298087 | 15.00000 | 22.40000 | 13.48000 | 0.279872 |
| Minimum | 0.066999 | 0.000000 | 0.000000 | 9.490000 | 0.217515 |
| Std. Dev. | 0.084477 | 6.390016 | 9.371385 | 1.680386 | 0.024801 |
| Skewness | 0.195001 | 1.071637 | 1.115693 | 0.317600 | -0.229517 |
| Kurtosis | 1.727358 | 2.310810 | 2.456040 | 1.648849 | 1.636865 |
| Jarque-Bera | 0.516752 | 1.478343 | 1.538535 | 0.650151 | 0.603415 |
| Probability | 0.772305 | 0.477509 | 0.463352 | 0.722473 | 0.739555 |
| Sum | 1.268791 | 25.69000 | 37.40000 | 79.05500 | 1.745257 |
| Sum Sq. Dev. | 0.042818 | 244.9938 | 526.9371 | 16.94219 | 0.003691 |
| Observations | 7 | 7 | 7 | 7 | 7 |

iii. Correlation Matrix.

***Table A3.*** *Result of Correlation Matrix.*

| **Covariance Analysis: Ordinary, Date: 07/25/24, Time: 23:59, Sample: 2017 2023, Included observations: 7**<br>**Correlation** | | | | | |
|---|---|---|---|---|---|
| **Probability** | **MG** | **GGB** | **CGB** | **INT** | **TO** |
| MG | 1.000000 | | | | |
| | ----- | | | | |
| GGB | 0.340908 | 1.000000 | | | |
| | 0.4543 | ----- | | | |
| CGB | -0.169875 | 0.244203 | 1.000000 | | |
| | 0.7158 | 0.5977 | ----- | | |
| INT | -0.371611 | -0.057130 | -0.267021 | 1.000000 | |
| | 0.4118 | 0.9032 | 0.5627 | ----- | |
| TO | 0.212192 | 0.130164 | 0.704739 | -0.208100 | 1.000000 |
| | 0.6478 | 0.7809 | 0.0770 | 0.6543 | ----- |

iv. Stationarity Test

***Table A4.*** *Result of ADF Unit Root Test.*

*MG at level*

| **Null Hypothesis: MG has a unit root, Exogenous: Constant, Lag Length: 0 (Automatic - based on SIC, maxlag=1)** | | | | |
|---|---|---|---|---|
| | | | **t-Statistic** | **Prob.*** |
| Augmented Dickey-Fuller test statistic | | | -2.700650 | 0.1258 |
| Test critical values: | 1% level | | -5.119808 | |
| | 5% level | | -3.519595 | |
| | 10% level | | -2.898418 | |
| *MacKinnon (1996) one-sided p-values. | | | | |
| Warning: Probabilities and critical values calculated for 20 observations | | | | |
| and may not be accurate for a sample size of 6 | | | | |
| Augmented Dickey-Fuller Test Equation | | | | |
| Dependent Variable: D (MG) | | | | |
| Method: Least Squares | | | | |
| Date: 07/25/24 Time: 23:59 | | | | |
| Sample (adjusted): 2018 2023 | | | | |
| Included observations: 6 after adjustments | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| MG (-1) | -1.261935 | 0.467271 | -2.700650 | 0.0541 |
| C | 0.240611 | 0.095951 | 2.507651 | 0.0662 |
| R-squared | 0.645814 | Mean dependent var | | 0.003350 |
| Adjusted R-squared | 0.557268 | S.D. dependent var | | 0.142023 |
| S.E. of regression | 0.094499 | Akaike info criterion | | -1.619245 |
| Sum squared resid | 0.035721 | Schwarz criterion | | -1.688658 |
| Log likelihood | 6.857734 | Hannan-Quinn criter. | | -1.897113 |
| F-statistic | 7.293509 | Durbin-Watson stat | | 1.833289 |
| Prob (F-statistic) | 0.054058 | | | |

*MG at first difference*

| **Null Hypothesis: D (MG) has a unit root, Exogenous: Constant, Lag Length: 0 (Automatic - based on SIC, maxlag=1)** | | | |
|---|---|---|---|
| | | **t-Statistic** | **Prob.*** |
| Augmented Dickey-Fuller test statistic | | -4.080201 | 0.0353 |
| Test critical values: | 1% level | -5.604618 | |
| | 5% level | -3.694851 | |
| | 10% level | -2.982813 | |
| *MacKinnon (1996) one-sided p-values. | | | |

**Null Hypothesis: D (MG) has a unit root, Exogenous: Constant, Lag Length: 0 (Automatic - based on SIC, maxlag=1)**

| | | **t-Statistic** | **Prob.*** |
|---|---|---|---|
| Warning: Probabilities and critical values calculated for 20 observations | | | |
| and may not be accurate for a sample size of 5 | | | |
| Augmented Dickey-Fuller Test Equation | | | |
| Dependent Variable: D (MG, 2) | | | |
| Method: Least Squares | | | |
| Date: 07/26/24 Time: 00:00 | | | |
| Sample (adjusted): 2019 2023 | | | |
| Included observations: 5 after adjustments | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D (MG (-1)) | -1.673090 | 0.410051 | -4.080201 | 0.0266 |
| C | -0.022103 | 0.056666 | -0.390057 | 0.7225 |
| R-squared | 0.847313 | Mean dependent var | | -0.004164 |
| Adjusted R-squared | 0.796417 | S.D. dependent var | | 0.279980 |
| S.E. of regression | 0.126327 | Akaike info criterion | | -1.010704 |
| Sum squared resid | 0.047876 | Schwarz criterion | | -1.166929 |
| Log likelihood | 4.526761 | Hannan-Quinn criter. | | -1.429996 |
| F-statistic | 16.64804 | Durbin-Watson stat | | 1.987504 |
| Prob (F-statistic) | 0.026587 | | | |

*GGB at Level*

**Null Hypothesis: GGB has a unit root, Exogenous: Constant, Lag Length: 0 (Automatic - based on SIC, maxlag=1)**

| | | **t-Statistic** | **Prob.*** |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -2.977593 | 0.0911 |
| Test critical values: | 1% level | -5.119808 | |
| | 5% level | -3.519595 | |
| | 10% level | -2.898418 | |
| *MacKinnon (1996) one-sided p-values. | | | |
| Warning: Probabilities and critical values calculated for 20 observations | | | |
| and may not be accurate for a sample size of 6 | | | |
| Augmented Dickey-Fuller Test Equation | | | |
| Dependent Variable: D (GGB) | | | |
| Method: Least Squares | | | |
| Date: 07/26/24 Time: 00:00 | | | |
| Sample (adjusted): 2018 2023 | | | |
| Included observations: 6 after adjustments | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |

| **Null Hypothesis: GGB has a unit root, Exogenous: Constant, Lag Length: 0 (Automatic - based on SIC, maxlag=1)** | | | | |
|---|---|---|---|---|
| | | | **t-Statistic** | **Prob.*** |
| GGB (-1) | -1.280116 | 0.429916 | -2.977593 | 0.0408 |
| C | 3.699363 | 3.232845 | 1.144306 | 0.3163 |
| R-squared | 0.689105 | Mean dependent var | | -1.781667 |
| Adjusted R-squared | 0.611381 | S.D. dependent var | | 10.44251 |
| S.E. of regression | 6.509792 | Akaike info criterion | | 6.845694 |
| Sum squared resid | 169.5096 | Schwarz criterion | | 6.776280 |
| Log likelihood | -18.53708 | Hannan-Quinn criter. | | 6.567826 |
| F-statistic | 8.866061 | Durbin-Watson stat | | 1.642330 |
| Prob (F-statistic) | 0.040836 | | | |

*GGB at first difference*

| **Null Hypothesis: D (GGB) has a unit root, Exogenous: Constant, Lag Length: 1 (Automatic - based on SIC, maxlag=1)** | | | | |
|---|---|---|---|---|
| | | | **t-Statistic** | **Prob.*** |
| Augmented Dickey-Fuller test statistic | | | -2.818773 | 0.1302 |
| Test critical values: | 1% level | | -6.423637 | |
| | 5% level | | -3.984991 | |
| | 10% level | | -3.120686 | |
| *MacKinnon (1996) one-sided p-values. | | | | |
| Warning: Probabilities and critical values calculated for 20 observations | | | | |
| and may not be accurate for a sample size of 4 | | | | |
| Augmented Dickey-Fuller Test Equation | | | | |
| Dependent Variable: D (GGB, 2) | | | | |
| Method: Least Squares | | | | |
| Date: 07/26/24 Time: 00:01 | | | | |
| Sample (adjusted): 2020 2023 | | | | |
| Included observations: 4 after adjustments | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| D (GGB (-1)) | -2.153424 | 0.763958 | -2.818773 | 0.2170 |
| D (GGB (-1), 2) | 0.351997 | 0.386690 | 0.910282 | 0.5299 |
| C | -4.690712 | 2.959430 | -1.585005 | 0.3583 |
| R-squared | 0.971218 | Mean dependent var | | -3.750000 |
| Adjusted R-squared | 0.913653 | S.D. dependent var | | 18.87459 |
| S.E. of regression | 5.546261 | Akaike info criterion | | 6.377831 |
| Sum squared resid | 30.76101 | Schwarz criterion | | 5.917551 |
| Log likelihood | -9.755661 | Hannan-Quinn criter. | | 5.367782 |
| F-statistic | 16.87183 | Durbin-Watson stat | | 0.975712 |

| **Null Hypothesis: D (GGB) has a unit root, Exogenous: Constant, Lag Length: 1 (Automatic - based on SIC, maxlag=1)** | | | |
|---|---|---|---|
| | | **t-Statistic** | **Prob.*** |
| Prob (F-statistic) | 0.169653 | | |

*CGB at Level*

| **Null Hypothesis: CGB has a unit root, Exogenous: Constant, Lag Length: 1 (Automatic - based on SIC, maxlag=1)** | | | |
|---|---|---|---|
| | | **t-Statistic** | **Prob.*** |
| Augmented Dickey-Fuller test statistic | | -5.438372 | 0.0113 |
| Test critical values: | 1% level | -5.604618 | |
| | 5% level | -3.694851 | |
| | 10% level | -2.982813 | |

*MacKinnon (1996) one-sided p-values.

Warning: Probabilities and critical values calculated for 20 observations

and may not be accurate for a sample size of 5

Augmented Dickey-Fuller Test Equation

Dependent Variable: D (CGB)

Method: Least Squares

Date: 07/26/24 Time: 00:01

Sample (adjusted): 2019 2023

Included observations: 5 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| CGB (-1) | -3.128792 | 0.575318 | -5.438372 | 0.0322 |
| D (CGB (-1)) | 1.201405 | 0.416866 | 2.881992 | 0.1023 |
| C | 18.02107 | 3.565667 | 5.054054 | 0.0370 |
| R-squared | 0.963694 | Mean dependent var | | 0.000000 |
| Adjusted R-squared | 0.927387 | S.D. dependent var | | 19.06253 |
| S.E. of regression | 5.136724 | Akaike info criterion | | 6.394417 |
| Sum squared resid | 52.77187 | Schwarz criterion | | 6.160080 |
| Log likelihood | -12.98604 | Hannan-Quinn criter. | | 5.765479 |
| F-statistic | 26.54346 | Durbin-Watson stat | | 0.756106 |
| Prob (F-statistic) | 0.036306 | | | |

*Int at Level*

| **Null Hypothesis: INT has a unit root, Exogenous: Constant, Lag Length: 1 (Automatic - based on SIC, maxlag=1)** | | | |
|---|---|---|---|
| | | **t-Statistic** | **Prob.*** |
| Augmented Dickey-Fuller test statistic | | -6.066488 | 0.0072 |
| Test critical values: | 1% level | -5.604618 | |
| | 5% level | -3.694851 | |

| **Null Hypothesis: INT has a unit root, Exogenous: Constant, Lag Length: 1 (Automatic - based on SIC, maxlag=1)** | | | |
|---|---|---|---|
| | | **t-Statistic** | **Prob.*** |
| | 10% level | -2.982813 | |

*MacKinnon (1996) one-sided p-values.

Warning: Probabilities and critical values calculated for 20 observations

and may not be accurate for a sample size of 5

Augmented Dickey-Fuller Test Equation

Dependent Variable: D (INT)

Method: Least Squares

Date: 07/26/24 Time: 00:02

Sample (adjusted): 2019 2023

Included observations: 5 after adjustments

| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
|---|---|---|---|---|
| INT (-1) | -1.308262 | 0.215654 | -6.066488 | 0.0261 |
| D (INT (-1)) | 0.428528 | 0.175399 | 2.443156 | 0.1345 |
| C | 13.94097 | 2.386634 | 5.841268 | 0.0281 |
| R-squared | 0.948457 | Mean dependent var | | -0.421000 |
| Adjusted R-squared | 0.896913 | S.D. dependent var | | 2.050587 |
| S.E. of regression | 0.658384 | Akaike info criterion | | 2.285654 |
| Sum squared resid | 0.866940 | Schwarz criterion | | 2.051316 |
| Log likelihood | -2.714134 | Hannan-Quinn criter. | | 1.656716 |
| F-statistic | 18.40114 | Durbin-Watson stat | | 2.087874 |
| Prob (F-statistic) | 0.051543 | | | |

*TO at Level*

| **Null Hypothesis: TO has a unit root, Exogenous: Constant, Lag Length: 1 (Automatic - based on SIC, maxlag=1)** | | | |
|---|---|---|---|
| | | **t-Statistic** | **Prob.*** |
| Augmented Dickey-Fuller test statistic | | -3.893132 | 0.0417 |
| Test critical values: | 1% level | -5.604618 | |
| | 5% level | -3.694851 | |
| | 10% level | -2.982813 | |

*MacKinnon (1996) one-sided p-values.

Warning: Probabilities and critical values calculated for 20 observations

and may not be accurate for a sample size of 5

Augmented Dickey-Fuller Test Equation

Dependent Variable: D (TO)

Method: Least Squares

Date: 07/26/24 Time: 00:02

| **Null Hypothesis: TO has a unit root, Exogenous: Constant, Lag Length: 1 (Automatic - based on SIC, maxlag=1)** | | | **t-Statistic** | **Prob.*** |
|---|---|---|---|---|
| Sample (adjusted): 2019 2023 | | | | |
| Included observations: 5 after adjustments | | | | |
| Variable | Coefficient | Std. Error | t-Statistic | Prob. |
| TO (-1) | -2.360948 | 0.606439 | -3.893132 | 0.0601 |
| D (TO (-1)) | 0.835079 | 0.367071 | 2.274978 | 0.1507 |
| C | 0.590228 | 0.150438 | 3.923397 | 0.0592 |
| R-squared | 0.895065 | Mean dependent var | | 0.002146 |
| Adjusted R-squared | 0.790130 | S.D. dependent var | | 0.039683 |
| S.E. of regression | 0.018179 | Akaike info criterion | | -4.893338 |
| Sum squared resid | 0.000661 | Schwarz criterion | | -5.127675 |
| Log likelihood | 15.23334 | Hannan-Quinn criter. | | -5.522276 |
| F-statistic | 8.529705 | Durbin-Watson stat | | 2.157073 |
| Prob (F-statistic) | 0.104935 | | | |

v. GLM Regression result

***Table A5.*** *Result of GLM Regression.*

| **Dependent Variable: D (MG), Method: Generalized Linear Model (Newton-Raphson / Marquardt steps), Date: 07/26/24 Time: 00:08, Sample (adjusted): 2018 2023, Included observations: 6 after adjustments, Family: Normal, Link: Identity**<br>**Dispersion computed using Pearson Chi-Square**<br>**Convergence achieved after 0 iterations**<br>**Coefficient covariance computed using observed Hessian** | | | | |
|---|---|---|---|---|
| **Variable** | **Coefficient** | **Std. Error** | **z-Statistic** | **Prob.** |
| D (GGB) | 0.017502 | 0.003404 | 5.142197 | 0.0000 |
| CGB | -0.013340 | 0.002745 | -4.860132 | 0.0000 |
| INT | 0.053010 | 0.021886 | 2.422090 | 0.0154 |
| TO | -1.815383 | 0.947730 | -1.915507 | 0.0554 |
| Mean dependent var | 0.003350 | S.D. dependent var | | 0.142023 |
| Sum squared resid | 0.004594 | Log likelihood | | 11.71451 |
| Akaike info criterion | -2.571504 | Schwarz criterion | | -2.710331 |
| Hannan-Quinn criter. | -3.127240 | Deviance | | 0.004594 |
| Deviance statistic | 0.002297 | Pearson SSR | | 0.004594 |
| Pearson statistic | 0.002297 | Dispersion | | 0.002297 |

vi. GLM for Moderating effect of Globalization

***Table A6.*** *Moderating Effect of Globalization on Manufacturing Sector Growth.*

**Dependent Variable: D (MG), Method: Generalized Linear Model (Newton-Raphson / Marquardt steps), Date: 07/26/24 Time: 00:11, Sample (adjusted): 2018 2023, Included observations: 6 after adjustments, Family: Normal, Link: Identity**
**Dispersion computed using Pearson Chi-Square**
**Convergence achieved after 0 iterations**
**Coefficient covariance computed using observed Hessian**

| Variable | Coefficient | Std. Error | z-Statistic | Prob. |
|---|---|---|---|---|
| D (GGB) | 0.015758 | 0.003799 | 4.148122 | 0.0000 |
| CGB | -0.012998 | 0.002751 | -4.725531 | 0.0000 |
| INT | 0.061710 | 0.023406 | 2.636574 | 0.0084 |
| TO | -2.269013 | 1.043883 | -2.173626 | 0.0297 |
| MED | 0.001444 | 0.001429 | 1.010999 | 0.3120 |
| Mean dependent var | 0.003350 | S.D. dependent var | | 0.142023 |
| Sum squared resid | 0.002272 | Log likelihood | | 12.24751 |
| Akaike info criterion | -2.415836 | Schwarz criterion | | -2.589370 |
| Hannan-Quinn criter. | -3.110506 | Deviance | | 0.002272 |
| Deviance statistic | 0.002272 | Pearson SSR | | 0.002272 |
| Pearson statistic | 0.002272 | Dispersion | | 0.002272 |

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