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GREEN BONDS FOR INTERNATIONAL RELATIONS AND SUSTAINABLE DEVELOPMENT GOALS: A COMPARATIVE ANALYSIS BASED ON DIFFERENT COUNTRIES

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Abstract: Green Bonds, in the past decade, has been a prominent tool for financing activities that could help the nations achieve the SDGs. Additionally, in this context, the role of international aid tends to be an important moderating factor. The primary purpose of the study was to investigate the role of green bonds in achieving SDGs and if there is a potential role of international aid as a moderating variable. The panel dataset consisted of 11 top countries of the world based on green bond issuance, and subsequently, the timeline for the study was eight fiscal years. The results implied that the issuance of Green Bonds is effective in reducing carbon emissions, thereby having a favourable effect on the achievement of the relevant SDG. Additionally, the realisation of the goals tends to be marginally better when the relationship is moderated by international aid. The findings are relevant to the Comparative Advantage Theory, and subsequently, in the practical scenario, it implies that the policymakers should take necessary steps to increase the acceptance of green bonds to help the nations to achieve the SDGs.

Keywords: *Green Bonds, Sustainable Development Goals, International Aid.*
JEL: F35, F64, Q56

1. Introduction

Green Bonds, as a sustainable investment tool, have gained significant importance, considering their risk-alleviating features and appeal to socially responsible and institutional investors. Tolliver, Keeley and Managi (2019) indicated that there is an increased prominence of green bonds in the sustainable development frameworks and the scenarios of climate change. Furthermore, there has been increased efforts made by the countries to embrace green bond financing and subsequently achieve the SDGs, and subsequently, the green bonds have been channelling resources towards fostering a green and resilient future (Sinha et al., 2021; Alamgir & Cheng, 2023). The radical shift in the area of development finance through the requirement of SDGs is worth an investigation in recent times, whereby financial aid has not only been limited to government sources but several private sources as well. Mawdsley (2018) indicated that there has been a major transition from the ODA or foreign aid to private financing. Therefore, the aids, through private financing, have grown significantly to leverage the investments for the business and wealth funds, venture capital, and other non-state sources. As

per Zhang et al. (2022), the role of sustainable development is an integration of the different environmental, social, governance, and economic objectives into investment or business decisions so that the SDGs are addressed. Therefore, financial aid is an important element in facilitating the interlink between green bonds and the achievement of SDGs.

On considering the interlink between Green Bonds, SDGs, and Foreign Aid, the primary purpose of the research is to investigate the causal relationship between Green Bonds and SDGs as well as to assess the moderating role of international aid in the realisation of sustainable goals. As a result, the study undertakes an empirical research strategy and, through econometric modelling, intends to identify the influence of green bonds on the achievement of SDGs.

One of the major rationales behind conducting the current study is that although the current finance and economics literature has focused on the aspects associated with the benefits provided by Green Bonds towards the achievement of SDGs, there is a limited discussion regarding the role of Foreign Aid and Grants as a tool to facilitate the SDGs goal accomplishment through Green Bonds.

2. Literature Review and Research Hypotheses

2.1. Theoretical Framework

The major focus of the current study is to undertake a comparison of the effectiveness of green bonds in different countries; the Comparative Advantage theory is likely to be prevalent in the concerned area. In common parlance, Comparative Advantage refers to the capability of a nation to produce goods and services at a lower opportunity cost. In other words, on comparing two countries, the one with a comparative advantage is likely to offer a product better or with a lower cost with the same resources. However, there is no direct link of the comparative advantage theory to the Green Bonds and SDGs. However, some areas might be relevant to establish the link. As per Belloc (2006), the transaction costs in international trade and imperfect information uncertainty are certain factors that provide comparative advantage. Therefore, considering the fact that some countries might be able to issue the bonds at lower costs as a result of the robustness of the financial markets or support of the government, thereby making them efficient as compared to the other countries.

Additionally, as per Schumacher (2013), international trade tends to be beneficial for all the nations participating as it tends to increase their production and consumption, thereby transforming the comparative production advantages into price advantages. This benefits the investors since the investor base and technological capabilities, which could be better in the case of the developed nations, would tend to provide more comparative advantage as compared to the other countries. Furthermore, the market maturity the, credibility, and governance are likely to be other factors that depend on the countries with stronger institutions and developed financial markets. Overall, in the case of the Green Bonds market and their impact on the SDGs, the effectiveness of the countries with managing bonds tends to be the source of comparative advantage.

2.2. Relationship between Green Bonds and SDGs

Green Bonds are special financial instruments that are used to finance sustainable development and environment-friendly projects. Bhutta et al. (2021) indicated that the improvement in the disclosure quality, favourable regulatory environment, and the

fundamental characteristics of the issuer are critical for their growth and give them certain advantages over other financial securities. There has been an increased allocation of green bond disbursements to projects that are focused on SDG-related investment categories, such as clean water, low-carbon transportation, and renewable energy (Tolliver, Keeley & Managi, 2019). However, Sinha et al. (2021) found that there is a negative influence of the green financing mechanisms on the transformational impacts of social and environmental responsibility, thereby implying that there is a need to design a framework so that SDG's objectives are addressed. Nevertheless, Nguyen et al. (2023) found that green bonds tend to reduce greenhouse and carbon dioxide emissions, thereby enhancing the rate of renewable energy consumption as well as accelerating towards SDGs. The effects, however, are contingent on the levels of institutional development of the countries that tend to issue the bonds.

Chang et al. (2022), in a study of the ten major countries supporting Green Finance, found that green financing tends to improve the quality of the environment in 80% of the countries. There are, however, several factors that drive the green finance-environmental quality nexus, namely asymmetry between the nations, the role of the authorities, and ecologically sustainable practices. Subsequently, from the financial perspective as well, Ahmed, Yusuf and Ishaque (2023) found that not only does the issuance of green bonds tend to drive the abnormal returns of the stocks, but they also tend to play an important bridging role towards SDGs as a result of consistent efforts of the investors and the firms towards SDG 13, which focuses on climate change. Similarly, Alamgir and Cheng (2023) found that the role of green bonds tends to be critical in the reduction of emissions as well as in improving the production of renewable energy. Since 2015, however, there has been a major impact, considering that the Paris Agreement was a major milestone in Sustainable Development whereby the 2030 agenda with 17 SDGs was found to be at the core.

Oguntuase and Windapo (2021) investigated the influence of green bonds as an investment vehicle. They found that in Nigeria, green buildings, tend to provide affordable and sustainable housing, thereby achieving different SDGs such as 3, 7, 12, and 13. The SDGs are critical in emerging and underdeveloped economies such as Nigeria, whereby the development of the green bond market has led to green building practices in the country. However, Maltais and Nykvist (2020) argued that despite their usefulness, there is a legitimate concern regarding the actual impact of green bonds. Nevertheless, there has been a creation of a new infrastructure within the capital markets, which consists of the guidelines such as green investment.

As per Sisodia, Joseph and Dominic (2022), green bonds tend to be valued more by the investors as compared to brown bonds. The former tends to provide a strong signal regarding the entity's commitment towards the environment. Furthermore, from the investor's financial benefit perspective, the companies issuing green bonds are likely to eradicate value erosion of the shares to a considerable extent due to their resilience in times of crisis. Green bonds have gained significant growth from USD 87.2 billion in 2016 to USD 257.7 billion in 2019 (Schumacher, 2020), thereby implying that the aspect of green bonds is synonymous with ESG-aligned investment securities. Furthermore, there are chances that the bonds are beneficial for the investors, considering the financial returns, taxonomical nature, and the other non-financial aspects that are critical in decision-making.

The issuance information of the bonds tends to be stronger for first-time issuers and those bonds that are certified by third parties (Flammer, 2021). The certification of green bonds by

third parties tends to be highly important, as in such situations, green bonds tend to be more effective in improving financial performance (Yeow & Ng, 2021; Flammer, 2020). However, there have been arguments regarding the effectiveness of green bonds, as although they tend to affect financial problems, there is an increase in agency costs. Nevertheless, from the investors' perspective, green bonds tend to yield more and have a lower risk as compared to normal bonds, in addition to being highly liquid (Bachelet, Becchetti & Manfredonia, 2019). Additionally, the emissions and experience in the ownership by the green and long-term investors tend to be one of the major aspects that are likely to make green bonds more effective for ESG/SDG-driven companies (Flammer, 2021). Subsequently, the major goal of the managers would not tend to shift from the maximisation of the profits to the environmental and social aspects, which thereby tends to raise several questions regarding their usefulness.

Additionally, in recent times, there have been concerns regarding the reduction and control of greenhouse emissions. The findings by Gabr and Elbannan (2023) further indicated that the green bond market has reached a size of $1651.92 billion as of FY 2021, thereby indicating that in the post-pandemic era, the gain has been around six times as compared to 2019. The role of green bonds has been critical in addressing the concerns and helping the economies to shift from high carbon-emitting energy to renewable energy, which is critical for development and growth. Lastly, the major SDGs have a 60% contribution, driven by an investment of $550 billion by the end of FY 2020. Therefore, on the basis of the findings of the past studies, it was evident that there is a significant influence of the issuance of Green Bonds on the achievement of SDGs.

H1: Green bonds can contribute to the realisation of sustainable development goals.

2.3. Moderating Effects of International Aid

Despite the fact that there is a possibility of the green bonds being directly effective in enhancing the SDGs, the role of foreign investments or aid tends to be critical for certain countries to meet their SDGs. Dhahri and Omri (2020), for instance, investigated the role of FDI and four other different types of foreign aid and found a positive and statistically significant influence of all the aid on the SDGs related to poverty reduction and hunger, specifically in those countries whereby there is a significant reliability on agriculture. The findings by Lopes et al. (2020) indicated that the role of foreign direct investments and foreign aid tends to be critical in the achievement of the SDGs and the underlying targets, which are a priority for the developing and developed economies.

However, certain issues arise in the case of funding, especially in underdeveloped regions such as Africa, where they have to depend on official development assistance (ODA) rather than any FDI. Similarly, in the case of the UAE, Krzymowski et al. (2022) found that the foreign aid received by the country as an element of branding tends to fill the SDGs and influence international relations, thereby helping the country achieve the SDGs making it very critical for the company to shape the environment. Furthermore, Mawdsley (2018) argued that the ODA tends to be critical in leveraging investment from the venture capitals, businesses, and sovereign funds, thereby reducing their effectiveness in the case of the development finance regime. This is in addition to the market-based borrowing and the private financing (Kharas, Prizzon & Rogerson, 2014). However, Arora and Sarker (2023) argued that during unprecedented times, the role of government expenses and financial aid tends to be critical in enhancing the fiscal capacity of both the developing and low-income nations. Explicitly, apart

from the achievement of the SDGs through different ways, such as helping the people to sustain their livelihood, foreign aid tends to foster the mobilisation of international resources so that there is an allocation of funds as per the requirements of the nations.

In recent times, there have been several ways through which the financing aids have been contributing to the SDGs, such as the public–private partnership, which tends to lays down the roadmap for SDG financing so that they can be achieved (Schmidt-Traub & Sachs, 2015), and concessional finance, which includes the development of infrastructure (Kharas, Prizzon & Rogerson, 2014). Nevertheless, in the pre-pandemic era, Shetty (2020) indicated that there is a scope to use several additional resources rather than the mobilisation of finances to finance the SDGs, with very limited attention to the domestic policy reforms and institutional environment. Furthermore, Runde, Metzger and Abdullah (2020) indicated that there is a need for several innovative measures so that the SDG financing gap could be filled and the overall reliance on foreign aid would not be very feasible. The following diagram provides an overview of the different financing aid options available to the companies:

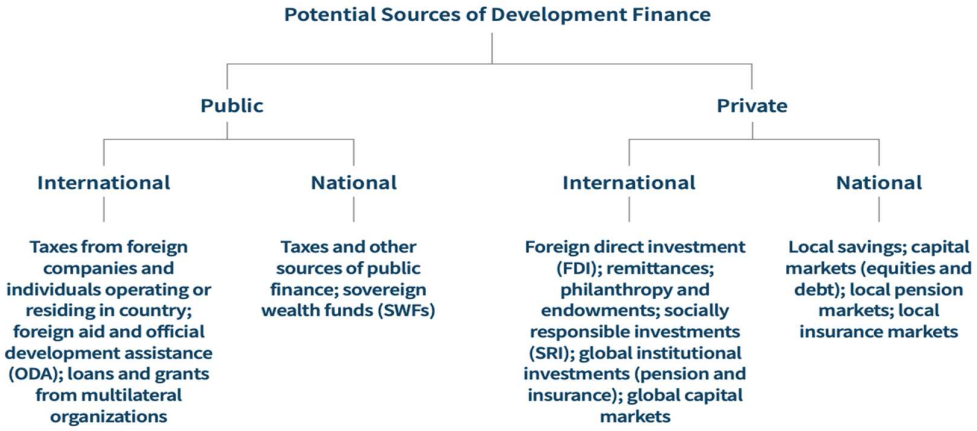

Figure 1: Potential Source of Financial Aid.
Adapted from Runde, Metzger and Abdullah (2020)

Evidently, there are several ways through which financial aid can be generated and subsequently be used as a facilitator of the SDGs through the usage of Green Bonds. Li, Rishi and Bae (2020) found that there is a critical role in mitigating the effects of carbon emissions when the funds are channelled to countries that have higher freedom of economic decisions as well as corruption. The role of the institutions tends to be important in the effectiveness of the green ODA. Therefore, country-specific differences are likely to prevail, which further provides scope for investigating the moderating role of financial aid and how it depends on the case of the different countries.

H2: Green bonds can accelerate the realisation of sustainable development goals through the intermediary effect of international aid.

The financial sustainability literature has provided a substantial premise to investigate the effect of green bonds on the achievements of SDGs. However, there is a very limited focus on whether international aid tends to play a role in enhancing the relationship between green bonds and SDGs.

3. Research Design

3.1. Econometric Modelling

In order to explore the relationship between green bonds and sustainable development goals, this paper first constructs an econometric model for preliminary regression analysis. The benchmarking econometric model is as follows:

$$\ln sdg_{it} = \alpha_0 + \beta_1 \ln gb + \beta_2 \ln pgdp + \beta_3 urban + \beta_4 rd + \beta_5 fdi + \mu_i + \lambda_t + \varepsilon_{it} \quad (1)$$

In addition, in order to clarify the intrinsic connection between green bonds and the SDGs, this paper refers to the relevant literature, introduces official aid as a moderating variable, and empirically examines the mechanism of green bonds on the SDGs based on the moderating effect model. The moderating effect model is constructed as follows:

$$\ln sdg_{it} = \alpha_0 + \beta_1 \ln gb + \alpha_1 \ln aid + \alpha_2 \ln gb * \ln aid + \beta_2 \ln pgdp + \beta_3 urban + \beta_4 rd + \beta_5 fdi + \mu_i + \lambda_t + \varepsilon_{it} \quad (2)$$

where subscripts *i* and *t* represent countries and years, respectively, and SDG_{it} denotes the sustainable development goals of country *i* in period *t*, μ_i, λ_t and ε_{it} denote the individual country effect, time effect, and random error term; the difference in the above models could be ascertained by assessment of the R-squared value and p-value of the moderating variable. The definitions of other relevant parameters and variables to be estimated are consistent with the above equation.

The above models would be tested using fixed-effects and random-effects modelling, which tend to be ideal for the panel dataset. Furthermore, the Hausman test would be used to estimate the most suitable model for the models. Although the panel dataset tends to be analysed best using the fixed-effects model, the Hausman test provides additional evidence regarding the choice of the ideal model. Furthermore, descriptive statistics and correlation analysis will also be conducted to summarise the features of the variables considered for the study and to identify the associations between them.

3.2. Variables and Proxies

Explained Variables

The Sustainable Development Goals (SDGs) are the dependent variable in this paper. Due to data availability, this paper uses Goal 13: Climate Action of the United Nations' Sustainable Development Report as a proxy variable; therefore, the natural logarithm of per capita carbon emissions is used to measure SDGs.

Core Explanatory Variables

Green Bond (GB) is the core explanatory variable of this paper. The green bonds in this aspect could be proxied by the amount of green bonds issued by the countries. This is proxied by the natural log of the aggregate amount of the Green Bonds issued by the countries and provided by the IMF website.

Control Variables

In order to mitigate the endogeneity problem caused by omitted variables, and with reference to the existing literature, the model adds control variables such as gross domestic product (PGDP) per capita, urbanisation rate (urban), R&D investment (rd) and foreign direct investment (FDI). PGDP can be expressed as the natural logarithm of PGDP, and urbanisation rate, R&D investment and FDI are ratios. These data can be collected directly from the websites of the International Monetary Fund and the World Bank.

Moderator Variable

International Aid (aid): this paper measures the moderating effect of the impact of green bonds on SDGs based on international aid. This could be proxied by the natural log of the aggregate amount of ODA. This data could be collected from the OECD websites directly.

In the empirical pursuit of elucidating the relationship between green bonds and carbon reduction, moderated by international aid, incorporating control variables such as Gross Domestic Product (GDP), Foreign Direct Investment (FDI), urbanisation, and Research and development (R&D) is imperative to account for the multifaceted nature of carbon emissions and to mitigate omitted variable bias. GDP and FDI are quintessential in capturing the economic and investment dimensions that inherently influence carbon emissions through production, consumption, and investment activities. This facilitates a nuanced understanding of the financial and economic substrates that underpin carbon emission trajectories. Urbanisation provides a lens through which the spatial and demographic factors influencing carbon emissions can be discerned, allowing for the incorporation of efficiencies and infrastructural aspects unique to urban locales. Conversely, R&D encapsulates the technological and innovative facets that are pivotal in driving transitions towards cleaner, less carbon-intensive technologies and practices. Given that the climate change discourse and associated policies are deeply intertwined with economic, demographic, and technological factors, these control variables serve to isolate and accurately delineate the impact of green bonds, ensuring that the resultant empirical findings are robust and reflective of the underlying dynamics within the investigated countries. This methodological approach, therefore, not only enhances the rigour of the empirical analysis but also fortifies the validity and generalizability of the findings across the sampled nations.

3.3.Data and Sample

The research is focused on the global context and tends to consider a sampling frame of all the countries and subsequently select 11 countries based on a purposive sampling technique. Chang et al. (2022), for instance, used a sample size of 10 countries and focused specifically on the environment-based SDGs. As per Statista (2023), China and the US have the highest number of green bonds issued, while the top 11 countries account for around 55% of the aggregate bond issued. The following figure indicates the top companies in the world that could be taken as the samples for the current study.

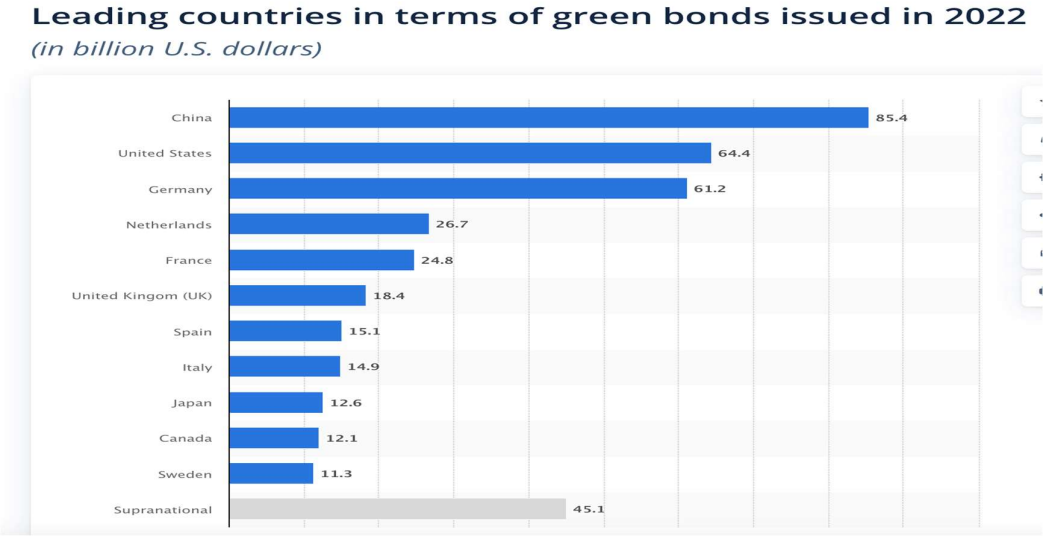

Figure 2: Countries with Highest Amount of Green Bonds
Source: (Statista, 2023)

Furthermore, as far as the timeline of the study is concerned, a longitudinal timeline of 8 fiscal years will be used for the study due to the availability of data, i.e., 2013 to 2020. Therefore, the panel dataset would consider 88 country-year observations. One of the major reasons for taking a very limited sample size and timeline is that the Green Bonds have been prevalent in the past decade, and only some of the major countries, which are developed or highly developing, tend to embrace it to enhance the SDGs. Thus, the sample size and the longitudinal timeline are justified for the current study.

4. Regression Results and Analysis

4.1. Descriptive Statistics

Table 2 below indicates the descriptive statistics of the variables under consideration. The study encompasses a total of [88] observations. The table delineates both average (mean and median) and variance statistics (standard deviation), as well as the minimum and maximum for each variable. The "lnsdg" variable, representing per capita carbon emissions, has an average value of 1.9907, suggesting a central tendency around 1.99. Its data spans from 1.1765 to 2.7795. The "lngb" variable, indicative of green bond issuance, holds a mean of 6.0192, with data ranging between 2.6780 and 8.7093. This range underscores the disparities in green bond issuance among countries, with nations like China showing significant issuance in recent years.

Table 1. Results Of Descriptive Statistics

Variables	Mean	Std. Dev.	Min	Max	Obs
once	1.9907	0.4460	1.1765	2.7795	88
lngb	6.0192	1.4783	2.6780	8.7093	88
lnaid	8.4398	1.2054	5.7048	10.4076	88
lnpgdp	10.4693	0.4973	8.8617	11.0135	88
urban	80.0171	9.3267	53.0130	92.2360	88
rd	2.2759	0.7208	1.1905	3.5272	88
fdi	2.8095	8.9034	-36.1404	43.4872	88

The GDP and the External Grants, on the other hand, have a significant difference, which is quite obvious, considering that there is a strong variability in the difference of the macroeconomic variables for certain countries. Similarly, in the case of International Aid, the difference is quite high, whereby the US has not received any aid in the past decade. In contrast, some countries have a significant amount of reliability on the aid to finance the SDGs. Lastly, another fact worth considering is the difference in the rank of the countries issuing green bonds and those having higher SDG index scores. Apart from Germany, France, and Sweden, none of the countries are likely to be effective enough to use their green bonds to finance their SDGs.

4.2. Correlation Analysis

The correlation analysis revealed two notably strong correlations: between lnaid & lnpgdp and lnpgdp & urban. The remaining correlations were relatively weak, indicating limited linear relationships among those variables. A significant positive correlation of 0.7439 between lnaid

and lnpgdp can be attributed to multiple factors. Aid often stimulates economic growth, with funds directed towards vital sectors such as infrastructure, health, and education, potentially boosting GDP. Conversely, countries with a higher GDP might attract more aid, either due to their proven ability to utilise resources effectively or their involvement in large-scale projects that draw aid.

Additionally, concurrent growth in both aid and GDP could be influenced by global economic trends, technological advancements, or international trade dynamics. Similarly, the strong positive correlation of 0.8238 between lnpgdp and urban can be understood in two ways. Urban areas, acting as centres for industries, services, and innovation, significantly contribute to GDP. The aggregation of resources, labour, and enterprises in cities can elevate productivity. On the other hand, as GDP grows, countries might invest more in urban infrastructure, leading to increased urbanisation. Factors such as technological advancements, policy shifts, or global economic patterns might simultaneously influence both GDP and urbanisation.

Furthermore, on considering the overall correlation matrix, there are no signs of a strong correlation, thereby indicating that there is no multicollinearity between the independent variables. Additionally, the VIF values also indicate that there is no multicollinearity.

Table 2: Results of correlation analysis and variance inflation factor test

Variables	lnsdg	lngb	lnaid	lnpgdp	urban	rd	fdi	VIF
once	1							
lngb	-0.0600	1						1.03
lnaid	0.3208	0.0530	1					3.24
lnpgdp	0.1403	-0.0048	0.7439	1				6.35
urban	0.0475	-0.0001	0.5058	0.8238	1			3.83
rd	0.0894	0.1533	0.4898	0.2973	0.3386	1		1.54
fdi	0.0552	-0.0661	0.0068	0.0291	0.0461	-0.0575	1	1.01

4.3. Regression Results

The results have been analysed based on the fixed-effects model. The FE model is often favoured due to its ability to control for unobserved time-invariant heterogeneity among units (e.g., countries firms). Specifically, the FE model eliminates the influence of these time-invariant characteristics by focusing on the changes within each unit over time. This ensures that any omitted variable bias arising from unobserved, constant characteristics is mitigated. The major differences in the five regression models lie in the inclusion of "lngb", "lnaid", or both as independent variables. Furthermore, Model 3 and Model 5 consider an interaction term to explore the moderating effect of aid on the relationship between GDP and SDGs, which is not present in the other models.

The analysis commenced with an exploration of the impact of green bonds on carbon emissions, as delineated in Model 1, which explains around 75% variability in carbon emissions. The statistical results found that all the control variables were significant, and the

green bonds have an adverse and significant influence on carbon emissions. Green bonds, often hailed as a sustainable financial instrument, play a pivotal role in the global effort to mitigate carbon emissions. Their influence can be dissected through several interconnected mechanisms, such as a targeted financing tool for green projects, stimulating green innovation, and signalling commitment. Furthermore, the stringent reporting requirements associated with green bonds tend to enhance their accountability and transparency. Moreover, green bonds tend to cater to the incremental cohort of socially responsible investors; they create a scope of mobilising funds towards projects that reduce carbon emissions.

Subsequently, model (2) explores the impact of international aid on carbon emissions, and the results show that international aid can significantly improve carbon emissions and contribute to the realisation of countries' sustainable development goals. While the R-squared value declined, considering that only 50% variability in the carbon emissions could be explained by this model. The relationship between international aid and carbon emissions can be intricate. However, several mechanisms can explain how an increase in international aid might lead to a reduction in carbon emissions, such as funding green projects, supporting policy reforms, and capacity building. Furthermore, a proportion of the international aid could be apportioned to R&D in fields such as clean energy, carbon capture, and sustainable agriculture, thereby fostering innovation through financial aid. The aspects of climate resilience and adaptation are likely to help countries in preparing and responding to the effects of climate change. Additionally, another aspect worth considering is that aid programs tend to be critical in incentivising conservation efforts, such as preserving forests that act as carbon sinks. Moreover, international aid can provide the necessary support for such transitions, such as technical expertise and financial resources, thereby ensuring that economic development in these countries is sustainable and less carbon-intensive.

Model (3) considers the interaction term of the green bonds and the international aid as the core independent variable. The R-squared value of the model implies that the interaction effect is likely to indicate more variability, i.e., around 78% of the carbon emissions. The interaction between international aid and green bonds can create a synergistic effect in reducing carbon emissions. The convergence of international aid and green bonds can amplify the reduction of carbon emissions through several intertwined mechanisms, such as leveraging financial resources as well as enhancing credibility and trust. Furthermore, international aid also tends to provide financing opportunities. Once these projects are deemed viable and sustainable, they can be financed through green bonds, ensuring a continuous flow of funds. Additionally, international aid can help establish clear regulatory frameworks, standards, and certifications for green bonds, making it easier for countries to tap into the green bond market to finance emission reduction projects.

Moving to model (4), both the explanatory variable and the moderating variable were considered. The results indicated that although both the variables were found to be significant and adverse determinants, the major difference lies in the fact that while it explains variability more than the first and second models, which tends to indicate the individual effects, it is still inferior to the third model in terms of explaining variability. In other words, the findings imply that the presence of both international aid and green bonds might not necessarily reduce carbon emissions in a better way. Interestingly, model (5), which considers all variables, indicates that the interaction term has a significantly negative effect on carbon emissions, which implies that

international aid strengthens the dampening effect of green bonds on carbon emissions, i.e., international aid strengthens the significantly positive effect of green bonds on the SDGs. This model explains the variability in the r-squared model better than the previous model. Interaction terms, such as the product of green bonds and international aid, allow for the modelling of a more intricate relationship between the predictor variables and the dependent variable, potentially capturing non-linear associations or dependencies that a simpler model may overlook. This added complexity can potentially explain more variance in the dependent variable, thus elevating the R-squared value.

A discernible positive correlation between green bonds and international aid underscores a multifaceted interplay of economic, financial, and policy-driven stimuli within the sustainable development arena. Both instruments, intrinsically rooted in sustainability endeavours, often witness a concomitant surge propelled by a mutual objective to amplify environmental and developmental initiatives. The issuance of green bonds, not merely a financial act, concurrently serves as a potent signal of a nation or entity's allegiance to environmental stewardship, potentially magnetising international aid that seeks to buttress these ecological commitments. Furthermore, the symbiosis between green bonds and international aid may be catalysed by policy and regulatory frameworks that concurrently incentivise sustainable financing and attract international aid, fostering a milieu where these financial mechanisms are mutually reinforcing. Market dynamics, particularly the escalating investor appetite for environmentally-aligned investment opportunities, may further intertwine the trajectories of green bonds and international aid as entities strive to align with prevailing ESG (Environmental, Social, and Governance) considerations and global sustainability trends. Ultimately, the interwoven relationship between green bonds and international aid underscores a complex yet pivotal financial synergy, warranting further empirical scrutiny to elucidate the underpinning mechanisms and implications for global sustainable finance and policy-making.

As far as the role of the control variables is concerned, their impact remained unchanged across the models. The empirical relationship between carbon emissions and several macroeconomic variables, namely Gross Domestic Product (GDP), Foreign Direct Investment (FDI), urbanisation, and Research & Development (R&D), unveils a complex tapestry of economic and environmental interlinkages. A positive association between GDP and FDI with carbon emissions can be discerned through the lens of escalating industrial and energy-intensive activities, concomitant with economic expansion and foreign capital infusion, respectively. This paradigm underscores a critical economic-environmental dichotomy, where the pursuit of economic augmentation potentially magnifies the carbon footprint. Contrastingly, urbanisation and R&D exhibit an inverse relationship with carbon emissions, potentially emanating from the enhanced efficiencies and innovative capacities inherent in urban locales and research-intensive environments. Urban agglomerations may afford economies of scale and technological adoptions that mitigate per capita emissions. However, R&D ostensibly propels the advent and deployment of cleaner, resource-efficient technologies, diluting the carbon intensity of economic activities. Navigating through these multifaceted relationships necessitates a holistic understanding of the underpinning mechanisms, ensuring that policy interventions and future research comprehensively encapsulate the nuanced economic and environmental dynamics intrinsic to these variables, thereby fostering a sustainability-oriented developmental trajectory.

Table 3: Panel Data Regression Analysis (Fixed Effects Model)

Variables	(1)	(2)	(3)	(4)	(5)
lngb	-0.0465***			-0.0441***	0.0676
	(0.0060)			(0.0054)	(0.0560)
lnaid		-0.0603**		-0.0277*	0.0490
		(0.0250)		(0.0136)	(0.0378)
lngd*lnaid			-0.0051***		-0.0125*
			(0.0006)		(0.0066)
lnpgdp	1.2848***	1.1346***	1.3134***	1.3139***	1.2955***
	(0.1157)	(0.1465)	(0.1007)	(0.1017)	(0.1255)
urban	-0.0184*	-0.0513**	-0.0302***	-0.0214**	-0.0446***
	(0.0090)	(0.0179)	(0.0082)	(0.0086)	(0.0137)
rd	-0.1921***	-0.2934***	-0.1559**	-0.1971***	-0.1016
	(0.0563)	(0.0890)	(0.0528)	(0.0520)	(0.0705)
fdi	0.0010**	0.0010*	0.0009**	0.0010***	0.0007*
	(0.0003)	(0.0005)	(0.0003)	(0.0003)	(0.0004)
Constant	-9.2720***	-4.6075**	-8.7342***	-9.1070***	-8.6073***
	(0.8393)	(1.6787)	(0.7509)	(0.7925)	(1.0344)
R^2	0.7450	0.4979	0.7753	0.7530	0.7881

Note: Standard errors in parentheses, *** p<0.01, ** p<0.05, * p<0.1

In summation, green bonds serve as both a financial instrument and a beacon for sustainability. Their strategic deployment can significantly expedite a country's shift towards reduced carbon emissions, aligning economic growth with environmental stewardship. Furthermore, international aid, when effectively targeted and managed, can act as a catalyst for structural changes in recipient countries, driving them towards pathways that are both developmentally sound and environmentally sustainable. Evidently, Model 5 and Model 3 explain the most variability in land, thereby implying that the interaction effects have a critical role to play in moderating the relationship. Suppose countries are utilising Green Bonds to invest in sectors where they have or seek to develop a comparative advantage (e.g., renewable energy). In that case, this might attract foreign investments and enhance trade opportunities in green goods and services.

The adverse impact of the interaction between Green Bonds and ODA on carbon emissions might suggest that financial aid could be influencing the sectors in which countries are developing, potentially diverting focus and resources away from areas where they might naturally develop a comparative advantage. The issuance of Green Bonds and the subsequent investment in green projects might indicate a strategic economic transition towards sectors that are more sustainable and potentially areas of comparative advantage. The substantial negative value of the interaction coefficient suggests that international assistance amplifies the mitigating impact of green bonds on carbon emissions.

Therefore, based on the above empirical results, the following are the results of the hypotheses:

- Hypothesis 1: The null hypothesis is rejected since the impact of green bonds on the SDG index score is significant.

- Hypothesis 2: The null hypothesis is rejected since the R-squared value is greater in the moderating model, as compared to the model, which do not have the moderating variable.

Primarily, the Green Bonds are typically used to finance projects that have positive environmental benefits, such as renewable energy, energy efficiency, and pollution control projects. The projects financed by Green Bonds often directly or indirectly lead to a reduction in carbon emissions. Secondly, the issuance of Green Bonds might signal a country's commitment to sustainability and reducing carbon emissions. Therefore, the issuing of Green Bonds might also have stringent regulations and policies aimed at reducing carbon emissions. Thirdly, funds from Green Bonds might be used for research and development of cleaner technologies. As a result, the deployment of cleaner technologies can lead to reduced carbon emissions per capita.

On comparing the results with the past studies, it could be seen that the findings of the current study are in line with several studies that have found that there is a significant and positive influence of the Green Bonds on the SDGs. For instance, the findings by Bhutta et al. (2021), and Tolliver, Keeley and Managi (2019) opined that there are several ways through which green bond allocation and disbursements tend to be effective in SDGs. Some of the key areas include disclosure quality, favourable regulatory environment, low carbon transportation, and renewable energy. Therefore, this implies that the capital allocations and the leverage of the private investment are some of the key areas whereby the reporting requirements and transparency could be enhanced. This is due to the fact that the favourable regulatory requirements would ensure that the issuers of the green bonds tend to follow the guidelines and that the funds raised are used for the intended purposes. From the financial performance and valuation perspective as well, Ahmed, Yusuf and Ishaque (2023) found that the issuance of green bonds tends to increase abnormal returns. This implies that the companies that are focused on green bond financing tend to have an increased value, and the investors have higher returns. In the economic context, there is a credit enhancement, and the countries could have a scope to raise low-cost financing as a result of risk mitigation.

Specifically, from the environment-based SDG measures, Chang et al. (2022) found similar results to this study as it proved that the quality of the environment is enhanced in the majority of the countries that tend to issue green bonds. The factors that tend to be critical include asymmetric information, authority's role, and sustainable practices. However, there have been arguments, such as the effects of the green bonds being contingent on the consumption of renewable energy (Nguyen et al., 2023) and transformational impacts of the environment and social responsibility (Sinha et al., 2021). Nevertheless, this could be eradicated to a certain extent by the concept of focused investment, which would ensure that the targeted impact of the green bonds is addressed through proper funding and the efficiency of the contributions could be enhanced by the focus being on those projects which are likely to create the most impact. In other words, if any area or aspect is found to receive limited funding or capital allocation, the priority-based capital allocation could help the companies to solve the problem of funding and resource allocation.

In the case of the moderating role of international aid, the findings could be claimed to be partially relevant to past studies. Dhahri and Omri (2020) and Lopes et al. (2020) indicated that there are certain specific goals addressed by financial aid if the focus is appropriate and the

focus is on developing and developed nations. Financial aid might be diverted to other urgent needs or sectors, reducing the effective utilisation of Green Bonds for carbon emission reduction projects. However, in the case of this study, the sample size was a diversified one, and some countries with less amount of international aid were not found to be relevant. Nevertheless, the variability or the effectiveness of the model improved, which implies that although international aid might not be a significant determinant of the SDG achievement, it can moderate the relationship between the green bonds and the SDGs. The FDIs, or the ODAs, tend to be relevant to the environment-related targets of the SDGs, and there might be chances that all the 17 SDGs might not be focused upon. However, countries receiving substantial financial aid might develop a dependency, potentially reducing their own efforts or investments in green projects. Additionally, the priorities of financial aid might not always align with the objectives of Green Bonds, leading to projects that do not effectively reduce carbon emissions.

Krzymowski et al. (2022) indicated that foreign aid shapes the environment and is an element of branding. Mawdsley (2018) indicated the role of foreign aid in leveraging the business from businesses and venture capital. There are chances that the influx of financial aid might create economic distortions, affecting the effectiveness of projects financed by Green Bonds in reducing carbon emissions. Overall, the effectiveness of international aid could be increased by focusing on the development of infrastructure (Kharas, Prizzon & Rogerson, 2014), public-private partnerships (Schmidt-Traub & Sachs, 2015), and several innovative measures (Runde, Metzger & Abdullah, 2020). Therefore, in the case of financial aid, the effectiveness could be enhanced by shifting the focus from public sources to private sources of funds so that the moderating role is enhanced.

As per the Comparative Advantage Theory, several inferences could be derived regarding the interlink between the Green Bond and the SDG achievement. Firstly, green bonds could be issued by the countries to those sectors or industries that tend to have a greater comparative advantage, thereby attracting additional investment and effectively contributing to the SDGs. Belloc (2006) indicated two factors to be critical in international trade, i.e., uncertainty and imperfect information, which provide a comparative advantage. Countries issuing Green Bonds might be investing in green technologies and industries, potentially developing a comparative advantage in these sectors. The reduction in carbon emissions might be indicative of a shift towards cleaner, more sustainable production, which could be an area where a country seeks to develop a comparative advantage.

Secondly, the countries which have a comparative advantage in the green finance instruments are likely to help others through different capacity-building measures, thereby making the achievement of SDGs through Green bonds effective globally. Thirdly, as far as efficiency and scale are concerned, which is one of the most essential aspects of the Comparative Advantage Theory, the green bonds-financed projects could achieve efficiency and scale quickly, and subsequently, the SDGs could be achieved. Another ancillary term related to the comparative advantage theory, which tends to be critical in this aspect, is policy synergy. The policymakers, through the alignment of the green bonds with those sectors where the countries have a comparative advantage, can create a 'reinforcing loop' between sustainable development and green finance.

4. Conclusion and Policy Recommendations

5.1. Research Conclusion

The primary purpose of the study was to investigate whether there is an impact of the Green Bonds on the SDG and the role of the financial aid received by the countries as the moderating variables. The research, through a panel dataset of 88 observations, investigated the effect of Green Bonds as a tool for international relations and whether they influence the SDG achievement of the countries. The independent variable of green bonds was proxied by the natural log of the green bonds issued, while the dependent variable was proxied by the natural logarithm of per capita carbon emissions. Furthermore, since this study considered a sample size of 11 countries, the external grants received by the countries and the GDP growth rate, urbanisation rate, R&D investment, and foreign direct investment had to be controlled for, considering that there was a significant disparity among the nature of the countries as per their development stage and the number of grants received.

The results of the Fixed-effects Regression Model, which was found to be feasible from the Hausman test, found that there is a significant and negative impact of the Green Bonds issuance on the SDG, and the role of the financial aids, as a moderator is also critical, as it tends to explain the model in a better way. Empirically, while the Green Bonds can explain a significant amount of variation in SDG alone, the moderating effect can help to increase the explanation of the variation, considering that the countries that have a better GDP tend to receive more financial aid and thus, they are able to capitalise it in such a way that the carbon emissions tend to be reduced.

Furthermore, the findings of the study are in line with the Comparative Advantage Theory, which indicates that the countries that have a better scope or opportunity to raise funds through Green Bonds are likely to have better SDG achievement. Interestingly, the control variables were found to be insignificant, thereby implying that the other grants or the GDP growth rate tend to be irrelevant for the countries if they have a major focus on the achievement of the SDGs through the number of green bonds raised. Overall, the findings provided significant evidence to reject both the null hypotheses and subsequently provide statistically significant results regarding the significant and positive influence of green bonds on SDG achievement.

One of the key scopes for future studies is to consider a sample size of 10 companies that are ranked in the top 10 of the SDG indices and then replicate the same model used in the current study. It would be critical to assess if the results of that study are in line with this study. Another recommendation would be to increase the sample size and test the empirical model for the companies in the same sampling frame.

5.2. Relevant Policy Recommendation

Several policy recommendations are relevant to the alignment of the green bonds and the achievement of the SDGs, which are critical for the current scenarios in the socio-economic landscape. Firstly, it is to be ensured that the green bonds are targeted towards those projects which are aligned with the objectives of the SDGs. Secondly, in the case of the multi-stakeholder environment, the interlink between the green bonds and the SDGs tends to facilitate the collaboration between the governments, NGOs, and the private sectors. This ensures that there is a calibration between the bond issuance and the utilisation of the bonds for the achievement of the SDGs. Thirdly, there is also a need to encourage the development of the technologies through which there is a dual benefit, i.e., financing of green bonds and

contribution to the SDGs. Additionally, international cooperation should also be a critical point on which the regulators could think, thereby making both the green bonds and the SDGs a part of the international agreements and dialogues. Lastly, it is also necessary for the policy makers to build public awareness about green bonds and how they can be a critical tool for the achievement of the SDGs in the global scenario.

The current study has certain limitations, such as a small sample size and consideration of only a limited number of explanatory variables. However, several plausible areas could be addressed by future researchers based on the premise provided by the current study. Firstly, future researchers could choose different explained variables, rather than the SDG 13 used by the current study and subsequently use the same set of variables and samples. This would provide insight regarding if the findings are relevant to other SDG factors as well. Secondly, the same model with the same set of explanatory variables could be applied to a different set of countries to ascertain if the results are similar or contradictory to this study.

References

Ahmed, R., Yusuf, F., & Ishaque, M. (2023). Green bonds as a bridge to the UN sustainable development goals on environment: A climate change empirical investigation. *International Journal of Finance & Economics*.

Alamgir, M., & Cheng, M. C. (2023). Do Green Bonds Play a Role in Achieving Sustainability? *Sustainability*, *15*(13), 10177.

Arora, R. U., & Sarker, T. (2023). Financing for sustainable development goals (SDGs) in the era of COVID-19 and beyond. *The European Journal of Development Research*, *35*(1), 1-19.

Bachelet, M. J., Becchetti, L., & Manfredonia, S. (2019). The green bonds premium puzzle: The role of issuer characteristics and third-party verification. *Sustainability*, *11*(4), 1098.

Belloc, M. (2006). Institutions and international trade: A reconsideration of comparative advantage. *Journal of Economic Surveys*, *20*(1), 3-26.

Bhutta, U. S., Tariq, A., Farrukh, M., Raza, A., & Iqbal, M. K. (2022). Green bonds for sustainable development: Review of literature on development and impact of green bonds. *Technological Forecasting and Social Change*, *175*, 121378.

Chang, L., Taghizadeh-Hesary, F., Chen, H., & Mohsin, M. (2022). Do green bonds have environmental benefits? *Energy Economics*, *115*, 106356.

Dhahri, S., & Omri, A. (2020). Foreign capital towards SDGs 1 & 2—Ending Poverty and hunger: The role of agricultural production. *Structural Change and Economic Dynamics*, *53*, 208-221.

Flammer, C. (2020). Green bonds: effectiveness and implications for public policy. *Environmental and Energy Policy and the Economy*, *1*(1), 95-128.

Flammer, C. (2021). Corporate green bonds. *Journal of financial economics*, *142*(2), 499-516.

Gabr, D. H., & Elbannan, M. A. (2023). Green finance insights: evolution of the green bonds market. *Management & Sustainability: An Arab Review*.

Kharas, H., Prizzon, A., & Rogerson, A. (2014). Financing the post-2015 sustainable development goals. *Overseas Development Institute, London*.

Krzymowski, A. (2022). Role and significance of the United Arab Emirates foreign aid for its soft power strategy and Sustainable Development Goals. *Social Sciences*, *11*(2), 48.

Li, D. D., Rishi, M., & Bae, J. H. (2021). Green official development Aid and carbon emissions: do institutions matter?. *Environment and Development Economics*, *26*(1), 88-107.

Lopes, J., Somanje, A. N., Velez, E., Lam, R. D., & Saito, O. (2020). Determinants of foreign investment and international aid for meeting the sustainable development goals in Africa: a visual cognitive review of the literature. *Sustainability Challenges in Sub-Saharan Africa I: Continental Perspectives and Insights from Western and Central Africa*, 161-187.

Maltais, A., & Nykvist, B. (2020). Understanding the role of green bonds in advancing sustainability. *Journal of Sustainable Finance & Investment*, 1-20.

Mawdsley, E. (2018). From billions to trillions' Financing the SDGs in a world 'beyond aid. *Dialogues in Human Geography*, *8*(2), 191-195.

Nguyen, N. M., Luu, N. H., Hoang, A., & Nguyen, M. T. N. (2023). Environmental impacts of green bonds in cross-countries analysis: a moderating effect of institutional quality. *Journal of Financial Economic Policy*.

Oguntuase, O. J., & Windapo, A. (2021). Green bonds and green buildings: New options for achieving sustainable development in Nigeria. *Housing and SDGs in Urban Africa*, 193-218.

Runde, D. F., Metzger, C., & Abdullah, H. F. (2020). *Covid-19 demands innovative ideas for financing the SDGs*. Center for Strategic and International Studies (CSIS).

Schmidt-Traub, G., & Sachs, J. D. (2015). Financing sustainable development: implementing the SDGs through effective investment. *Sustainable Development Solution Network.* Retrieved from: https://irp-cdn. multiscreensite. com/be6d1d56/files/uploaded/150619-SDSN-Financing-Sustainable-Development-Paper-FINAL-02. pdf.

Schumacher, K. (2020). Green bonds: the shape of green fixed-income investing to come. *Journal of Environmental Investing*, *10*(1).

Schumacher, R. (2013). Deconstructing the theory of comparative advantage. *World Social and Economic Review*, *2013*(2, 2013), 83.

Shetty, S. (2020). Accelerating progress of low-income countries towards the SDGs: Balancing realism and ambition in a post-COVID-19 world. *Center for Global Development, Washington (DC)*, 1-21.

Sinha, A., Mishra, S., Sharif, A., & Yarovaya, L. (2021). Does green financing help to improve environmental & social responsibility? Designing SDG framework through advanced quantile modelling. *Journal of Environmental Management*, *292*, 112751.

Sisodia, G., Joseph, A., & Dominic, J. (2022). Whether corporate green bonds act as armour during crises? Evidence from a natural experiment. *International Journal of Managerial Finance*, *18*(4), 701-724.

Statista. (2023). *Leading countries in terms of green bonds issued in 2022.* Retrieved from: https://www.statista.com/statistics/1289016/green-bonds-issued-worldwide-by-country/#:~:text=Green%20bonds%20issued%20in%20China,of%20green%20bonds%20in%202022.

Sustainable Development Report. (2023). Rankings: The overall performance of all 193 UN Member States. Retrieved from: https://dashboards.sdgindex.org/rankings

Tolliver, C., Keeley, A. R., & Managi, S. (2019). Green bonds for the Paris agreement and sustainable development goals. *Environmental Research Letters*, *14*(6), 064009.

Yeow, K. E., & Ng, S. H. (2021). The impact of green bonds on corporate environmental and financial performance. *Managerial Finance*, *47*(10), 1486-1510.

Zhang, Z., Zhu, H., Zhou, Z., & Zou, K. (2022). How does innovation matter for sustainable performance? Evidence from small and medium-sized enterprises. *Journal of Business Research*, *153*, 251-265.