Sovereign Green Bonds and Climate Change Mitigation in the Global South*

Ethan Hunt†

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Abstract

Climate finance is a critical element of the world's transition to sustainable development, especially in the Global South, yet little research has been done on whether location is an important element in the environmental impact of climate finance initiatives. Using six different data sources from 2000 to 2018, this paper explores whether green bonds yield greater carbon dioxide emission equivalent returns in the Global South compared to the Global North countries using fixed effects. The results indicate that the issuance of at least one sovereign GB is associated with 15% more greenhouse gas emissions the year after for the Global North. The relationship is less certain in the Global South. These results support the claim that this class of green bonds is an inadequate financial instrument to tackle the planet's climate challenges.

Keywords: Green Bonds, Sovereign Debt, ESG, Impact Investment, Climate Finance, Green Finance, Greenhouse Gas Emissions

JEL Codes: G10,G15,G18,H63,Q51,Q54

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†Department of Economics, the The College of Wooster,ethan@yellowtailbelize.com.

1 Introduction

Of the trillions of dollars invested in climate finance in recent years (Climate Policy Initiative 2024), sovereign green bonds (GBs) could be an essential part of the effort to address the climate crisis. It is critical that countries participate in this market considering their large financial capacities, and there is evidence that private GBs succeed in reducing greenhouse gas (GHG) emissions (Flammer 2021). Furthermore, GB investments may be one way to partially address a widely noted disparity amounting to hundreds of billions of dollars directed to Global North countries instead of the Global South (Climate Finance Solutions for Developing Countries, 2023). However, does reducing disparity have both normative and positive appeal for the savvy investor? If the goal of a GB is ultimately environmental improvement – with some traditional investment return, does it make a difference to invest in the Global South compared to the Global North, or, more importantly, should environmentally conscious parties invest at all? This paper analyzes the truthfulness of the implicit claim that sovereign GB investments are truly green by reducing GHG emissions and whether differences in locations adjust the environmental returns on these investments.

Scholars have conducted a similar return-based analysis on corporate GBs; specifically, they examine the effects of their issuance on corporate stock performance and environmental improvement (Fan et al., 2023; Fatica & Panzica, 2021; Flammer, 2020; Liu et al., 2024, p. 202). Analyses of corporate GB issuance by municipality have found similar observable effects on greenhouse gas (GHG) emission reductions (Alamgir & Cheng, 2023; Dill, 2023; Nguyen et al., 2023; Saha & Maji, 2023; Xu & Li, 2023) and lower yields compared to traditional bonds (Baker et al., 2018; Doronzo et al., 2021). A portion of this literature finds evidence that measures of institutional quality or designated development status are a major factor influencing whether these bonds reduce GHG emissions as intended (Nguyen et al., 2023; Saha & Maji, 2023).

The following paper conducts a novel analysis of the relationship between sovereign issued GBs and GHG emissions, where GHG emissions are measured using carbon dioxide equivalent units. First, it demonstrates that, unlike corporate GBs (Fatica & Panzica, 2021; Flammer, 2020; Xu and Li, 2023), issuance of at least one sovereign GBs is associated with 15.1% more GHG emissions rather than an emission reduction. This is consistent with the findings of Flammer (2020) and Fatica & Panzica (2021) in that independent supervision is an important factor in preventing green washing. Second, it notes the role of development status in moderating this relationship, demonstrating a differing association with GHG emissions between Global North and Global South countries.

This paper makes a twofold contribution to the GB literature. Firstly, it conducts a novel analysis of the effects of only sovereign issued GBs on GHG emissions on a large under-examined section of the global market. Second, it contradicts evidence in the existing literature on the role of development status in the

relationship between GBs and GHG emissions using different data sources and controls (Nguyen et al., 2023; Saha & Maji, 2023). However, it is important to reinforce that this paper analyzed only sovereign GBs while other authors authors examined the total amount of GBs issued in a given country.

2 Data and Methods

The data collected for this research spans from 2000 to 2018 for 37 countries. A dummy variable for GBs was also used to account for the lack of standardization across GBs, as utilized by Dill (2023). Development status reflects the UN classification for each country as either developing (or transitioning) or developed, and greenhouse gas emissions represent the amount of gas emitted each year in metric tons of CO_2. See Appendix A for a description, units, and sources and Appendix B for summary statistics of the data.

This question was investigated using pooled OLS, fixed effects, and random effects regression analysis with a one-step lag, interaction term, and inverse hyperbolic sine transformation on the value of GBs to account for skewness instead of the natural log. Additionally, there was a great deal of skewness towards the right tail of the distribution for the GHG emissions variable. To address this, the natural logarithm of GHG emissions was utilized for the dependent variable. The fixed effect specification (4) using the dummy for bonds issued was the preferred specification to account for potential serial correlation and concerns raised by Dill (2023), taking the form:

$$\begin{aligned} Y_{it} = \beta_0 &+ \beta_1 \text{GBDummy}_{i,t-1} + \beta_2 \text{Developing}_{it} + \beta_3 \left(\text{GBDummy}_{i,t-1} \times \text{Developing}_{it}\right) \\ &+ \beta_4 \text{GDP}_{it} + \beta_5 \text{EnergyIntensity}_{it} + \beta_6 \text{Urbanization}_{it} + \beta_7 \text{Trade}_{it} + \beta_8 \text{FDI}_{it} + \alpha_i + \gamma_t + \epsilon_{it} \end{aligned} \tag{1}$$

3 Results

Specifications (1) and (2) suggest that issuance of at least one GB is associated with greater levels of GHG emissions. As additional controls and a one-year lag is added, bias is removed from the estimates. The preferred specification (4) found the lagged GB variable significant at the 5% level, and the interaction term was also significant at the 5% level. These results suggest that a GB issued in the previous year is associated with a 15.1% increase in GHG emissions the subsequent year. Additionally, there are 21.7% less emissions on average in the subsequent year if the bond was issued in the Global South relative to the Global North. However, it is important to note this second result only estimates differences in the relative levels between these groups of countries. If we conduct a joint-hypothesis test on the coefficient of the GB dummy variable and the interaction term, the combined effect is insignificant. While GBs do damage in the developed world, the influence is statistically insignificant in the developing world.

A second series of specifications tested whether the value of these bonds issued in a year significantly affected greenhouse gas emission reductions, but the results were somewhat similar. Additional specifications using bond value can be found in Appendix C, and details regarding robustness checks can be found in Appendix D.

Table 1
Effect of Green Bond Issuance on Log GHG Emissions by Development Status

	(1) No Controls	(2) All controls	(3) Lagged GBs	(4) Fixed Effects
GB Dummy	1.389***	0.538**		
	(0.329)	(0.243)		
Developing	1.074***	0.759***	0.715***	
	(0.174)	(0.137)	(0.148)	
GBs*Developing	-0.489	-0.302		
	(0.489)	(0.343)		
Real GDP per Capita		0.0000105***	0.0000108**	0.00000386
		(0.00000403)	(0.00000438)	(0.00000366)
Energy Intensity		-0.342***	-0.423***	-0.00836
		(0.0911)	(0.0966)	(0.100)
Urbanization		0.0281***	0.0299***	-0.0200*
		(0.00421)	(0.00458)	(0.0106)
Trade		-0.0122***	-0.0117***	0.00553***
		(0.00111)	(0.00119)	(0.00123)
FDI		-0.0103***	-0.0110***	0.000560
		(0.00242)	(0.00240)	(0.000842)
Carbon Intensity		0.00279***	0.00291***	0.00289***
		(0.000256)	(0.000280)	(0.000421)
Population (in millions)		0.00366***	0.00369***	0.00121
		(0.000293)	(0.000309)	(0.00117)
Lagged GB Issuance			0.447*	0.151**
			(0.259)	(0.0746)
Lagged GB Issuance*Developing			-0.478	-0.217**
			(0.373)	(0.101)
Observations	536	536	437	437

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

4 Conclusion

Contrary to the wider literature on the environmental efficacy of GBs, I find that GBs are an imperfect instrument in reducing GHG emissions. However, it is possible that the issuance of these bonds is more

reflective of each country's financial development or demand for capital, which could be a sign of dirty industrialization and cancel any environmental benefit from GBs. In addition, the use of this investment is a clear principal-agent problem considering there is absolutely no oversight on this class of GBs. Findings by Flammer (2021) on the corporate GB market suggest that GHG emission reductions only occur on supervised GBs; lack of supervision or public attention on these environmental commitments has clearly negated any potential GHG emission reductions. Lastly, these GBs could simply be repackaged existing loans instead of new projects that would improve the environment. This would negate any environmental benefits, since there is no new GHG emission reduction activity.

Sovereign GBs are currently not an effective tool to tackle the climate crisis for both climate-conscious investors and policymakers. Investors should proceed with caution when investing in this class of bonds considering the subpar return (UNDP 2022) coupled with the lack of evidence of environmental benefits. For policymakers, GBs only will function if the necessary supervision is implemented, which will be costly and likely ineffective. Multilateral organizations or non-governmental organizations should consider providing supervision mechanisms to make this an asset class that benefits both investors and the planet.

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Appendices

A Variable Definition, Units, and Sources

Variable Name	Definition	Source
Dependent Variable		
Log greenhouse gas (GHG) emissions	Amount emitted in metric tons of CO_2; log taken to reduce skewness equivalent	Climate Watch
Independent Variable of Interest		
IHS GB Value	Amount of GBs issued in billions of US$. IHS transformation to reduce skewness. Missing values filled with zero.	IMF
Green Bond (GB) Dummy	Whether GBs were issued in that year; dummy variable	IMF
Developing	UN 2023 classification as developed/transitioning or developed; 0 if developed and 1 if developing	UN 2022
Other Independent Variables		
Urbanization	Percentage of population living in an urban area	World Bank
Population	Population in millions	World Bank
GDP per Capita	Real economic output per (millions of) persons (output-side)	Penn World Tables, Univ. of Groningen
Trade	Trade as a % of GDP	World Bank
Foreign Direct Investment (FDI)	Net inflows in BoP, current US$	World Bank
Carbon Intensity	Kilograms of CO_2 emitted per international dollar of GDP at 2011 prices	U.S Energy Adminsitration; Distributed by Our World in Data
Energy Intensity	Megajoules per international dollar at 2017 prices $ GDP	Global Carbon Project & Bold and van Zanden; Distributed by Our World in Data

B Data Summary

Variable	N	Mean	SD	Min	Max
Year	588	2,010	5.376	2,000	2,018
GHG Emissions	588	449.9	1,066	-186.7	6,406
Log Emissions	582	4.527	1.902	-1.386	8.764
GB Dummy	588	0.114	0.318	0	1
Value of Bonds Issued	67	1.376	2.029	0.00381	8.878
Development Status	588	0.594	0.492	0	1
GDP Output-side	588	1.192e+06	2.963e+06	10,487	2.016e+07
Population (millions)	588	79.64	204.5	0.280	1,353
Energy Intensity	588	1.422	0.672	0.570	4.890
Urbanization	588	65.29	19.01	21.98	93.81
Trade as % of GDP	588	84.74	54.44	19.56	362.4
FDI Inflow	588	5.980	22.23	-57.53	279.3
Carbon Intensity	588	405.2	217.1	20.69	791.9
GDP per Capita	588	24,987	20,597	1,520	105,845

C Alternative Specification

Table 2
Effect of the Value of Green Bonds (in billions of USD) on Log GHG Emissions by Development Status

	(1) No Controls	(2) All controls	(3) Lagged GBs	(4) Fixed Effects
IHS GB value	2.933***	1.136***		
	(0.875)	(0.402)		
Developing	1.612**	1.288***	0.951***	-0.886*
	(0.702)	(0.339)	(0.300)	(0.528)
IHS_bond_value*Developing	-2.348	-1.601**		
	(1.531)	(0.638)		
Real GDP per Capita		-0.00000151	0.00000227	0.00000183
		(0.00000702)	(0.00000579)	(0.00000214)
Energy Intensity		0.736**	0.937***	0.230
		(0.346)	(0.328)	(0.190)
Urbanization		0.0806***	0.0968***	-0.0397
		(0.00957)	(0.00873)	(0.0302)
Trade		-0.0125***	-0.0153***	0.00367**
		(0.00167)	(0.00188)	(0.00144)
FDI		-0.00661	-0.0192	0.00162
		(0.0132)	(0.0163)	(0.00217)
Carbon Intensity		0.00297***	0.00347***	0.000775**
		(0.000550)	(0.000481)	(0.000361)
Population (in millions)		0.00438***	0.00474***	0.00432***
		(0.000483)	(0.000403)	(0.00147)
Lagged Value of GBs			0.888**	-0.00475
			(0.387)	(0.0427)
Development Status * Lagged GB Value			-0.595	-0.0482
			(0.593)	(0.0556)
Observations	67	67	53	53

Standard errors in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

D Identification Challenges and Robustness Checks

Considering that the UN classifies countries partly based on GDP, there may be imperfect multicollinearity between development status and GDP within the model. Additionally, given that the time period spans over 18 years, significant changes during this period could lead to heteroskedasticity, resulting in inaccurate standard errors. As noted by Nguyen et al. (2023) and Tolliver et al. (2020), there may also be reverse causality, with greenhouse emissions creating political pressure to develop green financial instruments or pressure from nationally determined commitments to emissions reductions. Lastly, since GB issuance isn't an exogenous decision by policymakers, there may be factors that influence GB issuance like industrial structure that can also influence GHG emissions, potentially biasing estimates (Nguyen et al. 2023). In the GLS specifications, a fixed effects model was attempted to conduct the Hausman test, but the dummy dependent variable for development presented issues with collinearity. The Hausman test was run both without including Development Status and the Interaction Term, indicating that fixed effects should be used for specifications employing a dummy for bonds issued in a year, and random effects for specifications using the value of bonds issued. For specification 4, the Development Status variable was excluded from the regression because such a variable cannot be used in a fixed effects specification. A series of GLS regressions were also run without a one-step lag for GBs, but the results were similar, and theory indicates that a lag should be used. A VIF, Breusch-Pagan test, and correlation matrix were employed to test for robustness, but no evidence of heteroskedasticity or multicollinearity was found.