

Green Infrastructure in Developing Economies: A Unique Target for Risk Reduction and Financial Investment

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Abstract: Financing green infrastructure provides a unique opportunity for long-term investment with multiple benefits, including financial returns, reduced income inequality, and addressing high-impact areas. However, a dearth of suitable financial instruments in developing economies hampers the realization of these advantages due to high risks and costs for investors. We propose the Floating Green Carbon Credit Infrastructure (**FGCCI**) bond to catalyze green infrastructure investment in developing countries. The theoretical structure of the FGCCI bond leverages green bonds with floating rates, carbon credits, and other risk mitigation tools to bridge the investment gap. By aligning investor returns with sustainability outcomes, generating new revenue streams, and reducing risk exposures, FGCCI bonds have the potential to unlock significant private capital for green infrastructure projects that advance climate goals and sustainable development. Through analysis of funding challenges in developing economies and comparative assessment of financial instruments, this study elucidates the FGCCI bond's potential to mitigate investment risks, enhance returns, and achieve sustainability and conservation goals. The FGCCI bond could significantly reshape sustainable finance in developing economies, offering a robust model for innovative green investments.

Keywords: green bonds, blue bonds, debt for nature swaps, climate finance, financial innovation, floating interest rates, carbon credits, sustainable development, risk reduction, infrastructure investment, sustainability economics.

Key Policy Insights:

- Innovative financial instruments that align investor returns with sustainability outcomes and reduce risk exposures could catalyze much-needed private capital for green infrastructure in developing economies.

- Various financial instruments like green bonds, carbon credits, and debt-for-nature swaps are underutilized in developing economies due to currency risks, political instability, negative surplus projects, and greenwashing concerns.
- Risk reduction tools, such as floating rate structures, performance-linked returns, and asset backing, can be applied to green infrastructure projects to reduce risk exposure and enhance returns for investors.
- The proposed FGCCI bond combines green bonds with carbon credit and nature asset backing, floating rates tied to project milestones, biodiversity outcomes, and economic spillover effects.
- The FGCCI structure reduces investor risk and offers a more transparent approach by linking returns to measurable environmental and financial indicators, making green infrastructure projects in developing countries more attractive and viable for private capital.

1. Introduction

Human activities have significantly altered the planet for generations (IPCC, 2019). Climate change, manifesting through altered land use, extreme weather events, biodiversity loss, and more, poses unprecedented challenges to global sustainability (Houghton et al., 1996; IPCC, 2019). Investing in sustainable development, climate change mitigation, and infrastructure for the green transition has become a global priority, with many investors incorporating social and environmental values into their portfolios (Schoenmaker, 2017; Banga, 2019). Green infrastructure investment plays a crucial role in realizing these goals, as it may address environmental concerns, promote economic growth, and contribute to social equity (Gilchrist et al., 2021). Green infrastructure holds greater significance in developing economies, offering substantial sustainability benefits compared to developed counterparts (Gurara et al., 2018; Whistler, 2020; Armin Razmjoo et al., 2020). These countries grapple with heightened carbon emission intensity and encounter more daunting hurdles on the path to sustainable development due to economic constraints (Li et al., 2022). Despite the urgency of climate action, financing climate mitigation projects, especially through green infrastructure projects in low-income countries, remains an acute problem (IPCC, 2019; UNEP, 2022). Current financial tools are limited, and a clear investment gap persists. Therefore, fostering innovation of financial investment tools, particularly green bonds, and reducing investment risk would be extremely beneficial to the green transition.

Green infrastructure is a relatively new and flexible term; for this paper, the green infrastructure in focus is human-made or modified resources that either serve an ecological function or climate mitigation purposes. Green infrastructure projects offer benefits to the local population and opportunities in the green economy (Yadoo & Cruickshank, 2012; Streimikiene, 2022). These projects necessitate increased funding (Akenroye et al., 2017), particularly the mobilization of private

sector participation, which currently plays a limited role (Granoff et al., 2016; Polzin, 2017; Gurara et al., 2018; Kulkarni et al., 2022). Bonds have been shown as one of the only, and ordinarily the best, financial tools to support such projects (Banga, 2019; Sartzetakis, 2021). Some argue that existing bond structures are not sufficiently attractive to investors, given the risks associated (TheCityUK & Centre for Climate Finance & Investment, 2019).

This paper introduces a novel policy proposal and financial mechanism to improve investment tools and unlock financing for green infrastructure projects in developing economies, while also protecting the natural world: the Floating Green Carbon Credit Infrastructure (**FGCCI**) bond. The FGCCI bond is conceived to overcome barriers that conventional funding mechanisms face, such as high risks and uncertain returns. By integrating the issuance of green bonds with a floating rate, the generation of carbon credits, and ecological assets for biodiversity and conservation, this innovative bond aims to provide a mutually beneficial solution to investors and developing countries alike. Moreover, by setting bond returns to align with project outcomes, the FGCCI offers a more attractive risk-return profile, potentially transforming the sustainable finance landscape in developing economies.

The paper proceeds as follows. Section 2 provides an overview of financial instruments applicable to funding green infrastructure. Section 3 outlines financial risk reduction tools. Section 4 introduces the novel financial instrument, the FGCCI bond, discusses a hypothetical case, compares existing novel bond structures, and examines associated risks and mitigation strategies. Finally, the conclusion discusses the potential implications of the FGCCI as a foundation for financial innovation in mobilizing capital for sustainable development.

2. Green finance tools

2.1. Project Bonds in Developing Economies

Bonds are key financial instruments for debt financing (Pinches & Mingo, 1973). Governments and corporations issue conventional bonds to raise capital through debt securities, with interest rates negotiated in correspondence with the investment's risk profile and the issuer's credibility (Figure 1 and Figure 2) (Pinches & Mingo, 1973; Wrase, 1997).

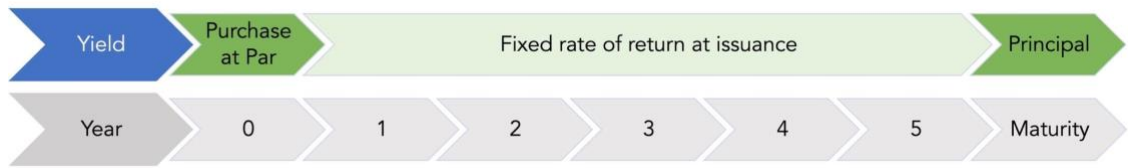


Figure 1: Example of the standard bond structure.

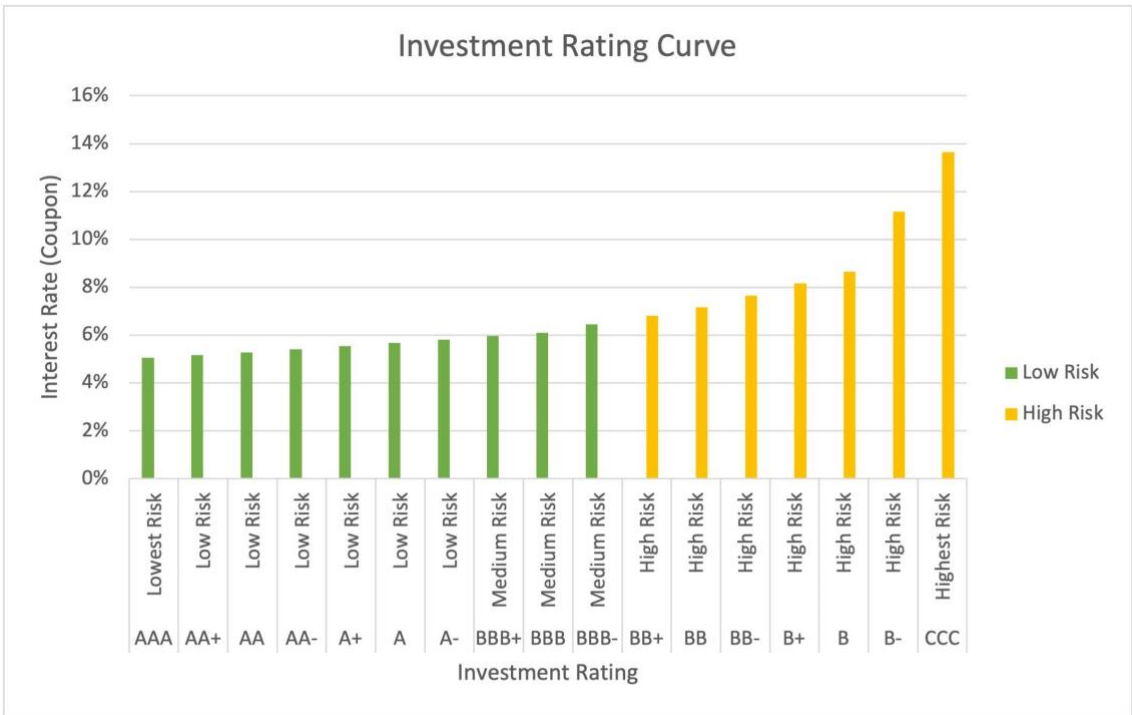


Figure 2: Yield compared to risk curve for bonds. Consider, for example, Switzerland has an AAA rating, and Ethiopia has a CCC rating (Bloomberg Markets, 2023; Martin, 2023).

Each country’s risk profile informs the pricing of debt instruments (Eaton et al., 1986; Oetzel et al., 2001). Bond issuance is considerably lower in developing economies due to heightened country risks that negatively impact bond pricing and marketability, such as inflation, lower per capita GDP, fiscal instability, and exchange rate fluctuation (Thomas, 2009; Gelos et al., 2011; Presbitero et al., 2016; Ng & Tao, 2016; Banga, 2019; Yamahaki et al., 2022). Consequently, these countries often pay higher interest rates, even due to the perception of risk (Gueye & Sy, 2015; Olabisi & Stein, 2015; Presbitero et al., 2016). Large infrastructure projects are often backed by a government-issue of project bonds to allocate costs to private investors and reduce the strain on public budgets (Favero et al., 2005; Hutchison et al., 2016; Li et al., 2017). However, the abovementioned risk profile in developing countries results in a significant gap in project bond issuance compared to wealthier nations (Thomas, 2009; Olabisi & Stein, 2015; Ng & Tao, 2016; Dhruva, 2018; Banga, 2019; Global

Infrastructure Hub, 2022). Research in Ghana and Nigeria reveals that the impacts of currency risks, lack of technical expertise in bond administration, inconsistent government policy, and investor perception of risk lead to weak project bond markets (Babatunde & Perera, 2017; Owusu-Manu et al., 2020; Bolomope et al., 2021; Kavishe et al., 2023).

Even subtle improvements in a country's risk profile can greatly enhance the attractiveness of bonds for international investment (Favero et al., 2005; Wrase, 1997; Montes et al., 2016).

2.2. Green Bonds in Developing Economies

Green bonds are a strategic tool against climate change, with new indices indicating their competitive performance (Engle et al., 2020; Gilchrist et al., 2021). Since the European Investment Bank issued the first Climate Awareness Bond in 2007 (European Investment Bank, 2023), various governments, development banks, and corporations have entered the green bond market (Sartzetakis, 2021; Moskowitz, 2022). Major economies, including the U.S., China, and France, have contributed to over half of the total green bond issuance from 2007 to 2017 (Banga, 2019; Gilchrist et al., 2021).

Green bonds in developing economies encounter unique challenges in addition to the risks of conventional project bonds (Banga, 2019; Liberati & Marinelli, 2021; Caramichael & Rapp, 2022; Wass et al., 2023). Factors include high certification costs for green labeling (Banga, 2019; Sartzetakis, 2021), underdeveloped credit rating systems, and domestic macroeconomic variables (Tolliver et al., 2020; Jun et al., 2016; Cochu et al., 2016). Consequently, green bonds are rarely issued for public infrastructure projects in developing economies (Gilchrist et al., 2021).

Recent innovations in green bond structures have enabled the issuance of limited but novel instruments for climate mitigation. For instance, the Belize Blue Bond restructured Belize's sovereign debt with incentives to protect 30% of its ocean (Field, 2022). Partnering with the U.S. Development Bank, the bond achieved an Aa2 rating, improving from Belize's previous Caa rating, and the debt restructuring increased Belize's foreign currency sovereign credit ratings from SD/SD to CCC+/C (Baria, 2020; Bala et al., 2022). Additionally, Sustainability-Linked Bonds (**SLBs**) have predetermined sustainability performance targets linked to financial incentives to encourage ESG performance (Ul Haq & Doumbia, 2022; Kölbel & Lambillon, 2022).

2.3. Carbon Credits and Debt for Nature Swaps

While bonds have been a dominant mechanism in green finance, other instruments have played a pivotal role in the emerging carbon and biodiversity markets.

Carbon credits, a relatively new financial instrument that emerged from the Kyoto Protocol, are financial instruments that represent one ton of carbon dioxide, or the equivalent amount of another greenhouse gas, reduced, sequestered, or avoided. These credits are generated by projects that reduce or remove greenhouse gas emissions from the atmosphere, such as renewable energy installations (UNDP, 2022; UNFCCC, 1997, 2015, 2024). Voluntary carbon credit markets that allow the trading system for companies and individuals to buy and use carbon credits to compensate for their greenhouse gas emissions are growing in size, transparency, and credibility (Lee et al., 2018). Corporate interests in securing quality carbon credits have surged in recent years, and this market has the potential to significantly drive climate action (Streck, 2021). Carbon credits are often undervalued, failing to offer sufficient incentives to align investment with Paris Agreement goals (Stiglitz et al., 2017). Higher prices could promote more environmentally friendly practices (Stiglitz et al., 2017), and increased governmental engagement is expected to enhance their efficacy (Shrikanth, 2020).

Green financial tools can also leverage ecological assets to protect biodiversity and natural ecosystems. Debt for nature swaps (**DNS**), introduced by Thomas Lovejoy, allow countries to preserve their natural environments by exchanging their debt obligations for investments in biodiversity conservation (Lovejoy, 1984; Thapa, 1998). Despite limitations, including the lack of financial returns for investors, Lovejoy's innovation shaped modern financial tools that align with conservation efforts, such as the KFA Global Carbon ETF (Shrikanth, 2020) and Belize's Blue Bond (Field, 2022).

Projects reducing environmental degradation and carbon footprint are also eligible to generate carbon credits (UNFCCC, 2024). The developing world is rich in biodiversity hotspots crucial for global ecosystems but has not capitalized on these assets. These areas hold significant ecological value relative to national GDPs, yet "conservation resources are scarcest" where they are needed most (Myers et al., 2000). Investment in the developing world's natural ecosystems will likely have a larger impact on global biodiversity than investments elsewhere.

3. Financial risk reduction tools in green bonds

There are several risk mitigation mechanisms specific to infrastructure projects, green investments, and developing economies that can be leveraged to reduce the high risk of financing these projects. Additionally, we explore how risk reduction can be achieved by countries capitalizing on natural assets.

3.1. Floating rate

While a conventional bond often has a fixed rate (Figure 1), a floating interest rate can fluctuate according to several risk reduction mechanisms.

3.1.1. The Spillover Effect

Infrastructure projects often have continued sources of revenue from direct user charges, tax revenues, and other benefits that only materialize once the high upfront costs of the project are overcome. These positive economic impacts of infrastructure projects for a region are known as the “spillover effect”, which can be captured by floating rates tied to ancillary indices (Wrase, 1997; Yoshino et al., 2021). Yoshino et al. (2021) illustrate this with a high-speed railway in Japan, where post-construction tax revenues increased significantly: personal income tax and corporate tax increased 7 times and 26 times, respectively. When infrastructure user charges and spillover tax revenue combined exceed the government bond interest rate, the floating rate can offer higher returns. Conversely, when these revenues fall short, the rate can match the government bond rate, with spillover revenue compensating for early losses.

3.1.2. Step-up Mechanisms for Project Milestones

Project milestones could also be used to guide floating return rates. Missing revenue-generating milestones can drastically increase the risk of project failure. A moral hazard arises when projects behind schedule may default later in the project, which is not immediately clear to investors (Hyun et al., 2008; Lewis & Bajari, 2014; Owusu-Manu et al., 2020). Step-up mechanisms for project milestones can directly correlate to the floating interest rate. Key project milestones, like construction completion, operational targets, and verified emissions reductions, would trigger predetermined step-up clauses with appropriate interest rate caps. Enel issued the world’s first SLB that ties the coupon to power-generating infrastructure milestones (Enel, 2019). Incentivizing timely milestones, penalizing delays, or both, can reduce risk and increase project viability.

3.1.3. GDP-Linked Bonds

The issuance of sovereign bonds in countries with volatile economies makes a fixed coupon a risky endeavor. GDP-linked bonds are a debt security with floating coupon payments tied to the issuing country’s GDP (Bowman & Naylor, 2016). The debt-to-GDP ratio is more stable than conventional bonds, holding all else constant (Bowman & Naylor, 2016). This type of bond has been

released in many countries, such as Argentina in 2005, Greece in 2012, and Ukraine in 2015 (Bowman & Naylor, 2016). Therefore, the government's burden of servicing its debt is lessened during an economic downturn reducing risk to investors.

3.2. Asset Backing

Bond risk is associated with many metrics, including the assets backing the bond and the financial strength of the issuing institution (Moody's Investors Service, 2009). Most of the rating system is based upon the assets backing the debt security (AP-Dow Jones, 1989), leading to most investments funded by governments having the same debt rating as the government itself. Various assets could be used to back a bond. For instance, TWA made light bulb bonds in which physical spare parts and light bulbs were used to back the bond (AP-Dow Jones, 1989). A way to reduce risk in bond issuance would be to increase the assets backing the bond.

Carbon pricing and taxation are large sources of revenue for green infrastructure projects, and it has been shown that green bonds perform better when combined with carbon pricing or credits (Heine et al., 2019; BIS Innovation Hub, 2022). For example, the recent World Bank Emission Reduction-Linked Bond carbon credits can be used to back the bond as a fixed asset or as future revenues (World Bank, 2024). In addition, asset-backing green bonds through carbon credits fills a financial viability gap and reduces greenwashing (BIS Innovation Hub, 2022). Other examples of carbon credit-backed bonds include Project Genesis 2.0 (BIS Innovation Hub, 2022) and World Bank proposals (Heine et al., 2019). These risk-reduction tools provide immense opportunities for risk reduction when combined into a single instrument.

4. Floating Green Carbon Credit Infrastructure (FGCCI) Bond

In reviewing current green financial tools for developing economies' infrastructure, our new bond combines these risk-reduction measures into a single solution. The FGCCI bond links financial incentives to critical policy outcomes, promoting good governance and effective delivery of green infrastructure.

No current bond uniquely combines greater asset backing with a floating rate that captures future green infrastructure benefits and reduces moral hazard through project milestone mechanisms. The FGCCI capitalizes on the unique characteristics of green infrastructure in developing economies to create an attractive financial instrument benefiting society, environment, and economy (Figure 5). These risk-reducing factors should enhance the FGCCI's desirability, allowing for a reasonable floating rate and payback period to increase viability.



Figure 5: Benefits of the proposed FGCCI bond structure.

4.1. Country G

To illustrate the practical application of the proposed FGCCI, we present a hypothetical case focused on Country G.¹ This case demonstrates how the integration of these risk mitigation mechanisms can be effectively employed to finance green infrastructure projects in developing countries.

Suppose Country G aims to transition its energy sector to 100% renewable sources and plans to construct a large-scale solar farm to meet its electricity demand of 1 million megawatt hours (MWh) per year. The estimated cost of this solar project is \$500 million (Fuller et al., 2009). The project's revenue would be generated through user charges only at the end of the project completion (assuming electricity rates of \$0.10 per kWh), the user charges would equate to \$100M per year.

Traditionally, Country G would attempt to fund the project by issuing an infrastructure bond to investors with the promise to repay the cost of the bond with a fixed interest rate. However, like many developing countries, suppose Country G does not have a strong credit rating. In that case, the risk of default on the bonds will significantly raise the interest rate required for investors to find a bond attractive. Due to the high upfront costs and high-interest payments, this project would likely

¹ This is an illustrative example, numbers are realistic but not precise.

be priced out at inception. Our proposal would make this investment viable and more attractive to institutional and other private investors.

The floating rate can be tied to as many metrics as Country G would choose to use. The metrics that can influence that rate are outlined below; these can be used individually or together, and would likely influence the rate by increasing or decreasing a few basis points (Figure 6):

- Spillover effect: Once operational, increased user charges and tax revenues could be used to influence the floating rate, increasing later in the life of the bond (Yoshino et al., 2021).
- Step-up mechanism and milestones: Using the Enel bond as a foundation, Country G could introduce a step-up mechanism (Enel, 2019). If risk-reducing milestones are met, the interest rate could be reduced.
- GDP-linked: The coupon could connect to the GDP ratio of Country G, reducing currency risk.
- Carbon credit production and asset backing: Incorporating carbon credits into the bond structure offers a means to tap into the emerging carbon market and create an additional revenue stream by leveraging its natural assets and biodiversity, similar to DNS. Given the volatility of carbon credit pricing, this example adopts a reasonable value according to the July 2020 EU valuation (Hodgson, 2020). Assuming carbon credits associated with solar energy are valued at \$9 per MWh (Mukherjee & Ghosh, 2014), the project to provide 1 million MWh per year for Country G could generate an annual income of \$9 million solely from carbon credits.

The preservation of previously unprotected forest areas could result in carbon credits for its protection as national park; it could offer 0.57 carbon credits per acre, each valued at \$36.73 (Banasiak et al., 2015; Hodgson, 2020). If Country G were to allocate 4.8 million acres of land for this purpose, it could generate approximately 2.7 million carbon credits. These credits could be sold internally if the country has an internal cap-and-trade system or on a global carbon credit marketplace (Stiglitz et al., 2017; European Parliament, 2022). Using carbon credits in Country G worth approximately \$100 million, a new national park could fund 20% of the project while simultaneously protecting biodiversity in a lasting, internationally recognized way. Therefore, combining carbon credits with a green bond allows two important incentives. First, the issuance of carbon credits can be used to asset back the bond. Second, the fluctuation of the value of the generated credits can attach to a floating rate for the bond, incentivizing the protection of the value of the credit and completion of the project.

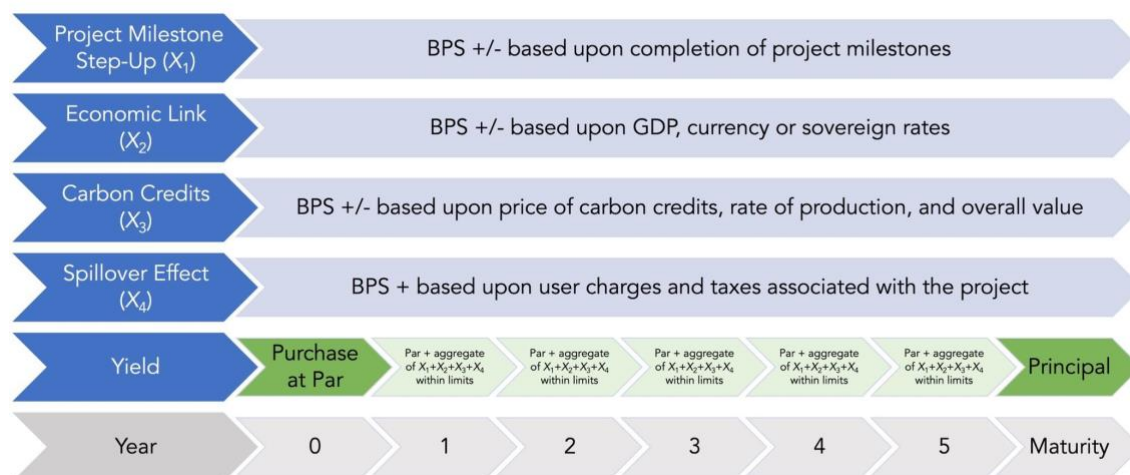


Figure 6: In the FGCCI structure, yield is tied to various risk-reducing mechanisms.

The project costs could be funded by a green infrastructure bond issued with a standard treasury rate of 14% by Country G. However, unlike a traditional project bond, a floating rate can reduce early project costs of capital, eventually having a higher return to capture the \$9 million annually from the carbon credits and \$100 million per year in user charges after the completion of the project.

While the floating rate is attractive for investors to reduce interest rate risk, it does increase the credit risk of the obligor. However, as outlined in Figure 6, the collation of floating rate modifiers aims to reduce the overall credit risk. The use of multiple rate modifiers, including GDP-linkage and carbon credit revenue, aims to provide the obligor with a more stable revenue stream to service the debt, even as base rates fluctuate. Additionally, the enhanced asset backing through the securitization of carbon credits and other green infrastructure cash flows is intended to further mitigate the credit risk for the investor. This shared reduction in overall project risk is a key design consideration, as it allows the FGCCI to maintain investor appetite while also ensuring affordability and feasibility for the obligor, especially in high-risk developing country contexts.

By aligning investor returns with policy goals, this novel bond structure can create targeted incentives for governments and private institutions that address limitations in existing green bonds and instruments underutilized in developing world contexts. The weight of each factor in Figure 6 could be increased or decreased depending on the target investor market and issuing country. A reduction in risk profile, even a few basis points, would allow for significant investment, enabling private investors to support sustainable development in Country G.

4.2. Comparison to innovative green bonds

In order to contextualize the impact of the FGCCI bond, it is worth comparing it to the aforementioned innovative green finance instruments. As an early starting point, DNS are pioneering mechanisms to target sovereign debt and protect biodiversity, but remain limited in scale and application (Nedopil et al., 2024). Defining which nature and what debt to swap creates uncertainty and complex negotiations (Shalal, 2021; Nedopil et al., 2024). Unlike DNS, the FGCCI bond offers better scalability, defined scope, investor returns, and focus on funding green infrastructure. Unlike DNS, which minimally impact a country's credit rating, the FGCCI can significantly fund green infrastructure while potentially improving a country's financial standing.

Recent innovations to green bond structures for sustainable outcomes are more relevant to the FGCCI structure. In a specific example, the Belize Blue Bond transformed the country's financial landscape in exchange for ocean conservation (The Nature Conservancy, 2022). With the lower risk rating, the Belize Blue Bond was able to open investment to a different class of private investors, changing the landscape for sustainable finance (Owen, 2022). The bond offers a low-risk return for a financial instrument inspired by DNS, while allowing investor returns. One of the critical aspects of the risk profile of the Blue Bond is Credit Suisse agreeing to underwrite and the International Development Finance Corporation agreeing to insure the bond and coupon (Owen, 2022). The reliance on large institutional participation creates a barrier for the issuance of similar bonds in the future. The greatest risk-reducing feature of the Belize Blue Bond is that it is backed by reputable financial institutions, not inherently due to innovation of the structure of the bond itself. The FGCCI bond aims to achieve similar effects without the need for extensive international banking support.

One more general case is SLBs that have been designed to improve ESG performance. The FGCCI is similar to SLBs in that sustainability performance targets influence the coupon rate (Ul Haq & Doumbia, 2022, Kölbel & Lambillon, 2022). SLBs have notable structural loopholes with low penalties, delaying target dates, or early bond calls (Ul Haq & Doumbia, 2022, Kölbel & Lambillon, 2022). However, the FGCCI structure and connection specifically to projects may help with closing some of these loopholes due to the influence of multiple rate modifiers in addition to sustainability targets.

Project Genesis 2.0 is a bond that integrates future values of carbon credits that are pledged as part of the coupon, referred to as mitigation outcome interests (MOIs) (BIS Innovation Hub, 2022). By only reducing risk with a carbon forward, this tool is limited in scope and is still exposed to all other risks associated with a project bond in a developing economy. The FGCCI structure would

reduce overall risk further and likely have more broad applicability, although incorporation of MOI is not mutually exclusive.

4.3. Risks and limitations

Introducing new financial instruments for green infrastructure in developing economies presents risks in terms of transaction costs, white and green elephants, greenwashing, and governance.

Transaction costs will increase by integrating diverse financial tools into the FGCCI framework, which can potentially diminish the bond's yield and attractiveness to investors (Edwards et al., 2007). High transaction costs are a critical concern, as they directly impact the bond's financial viability and market appeal. As the green bond market grows, standardized certification processes, knowledge sharing, and capacity building can enhance accessibility and attractiveness to investors (Banga, 2019; Sartzetakis, 2021). More transparency through improved certification and governance will foster innovative market structures, further reducing transaction costs (Edwards et al., 2007). While governance is critically important for the issuance of a complex, multifaceted green bond like the FGCCI, it introduces notable transaction costs (Man et al., 2015), which can be offset when holistically considering all the advantages of carbon load reductions (Matthews, 2008).

Projects with a negative social surplus, called white elephants (Robinson & Torvik, 2005; Ganuza & Llobet, 2020), typically arise from overly optimistic forecasts, insufficient due diligence in project feasibility assessments, and misalignment between the project goals and the actual utility it provides. Political motives, prestige-seeking by decision-makers, or a lack of thorough cost-benefit analysis are exacerbating factors (Robinson & Torvik, 2005; Ganuza & Llobet, 2020). Financial structures, including public and private partnerships, may help avoid white, or in our case green, elephants because private companies will usually not support projects that are unprofitable and require thorough cost-benefit analysis (Engel et al., 2014). While it is essential to address the technical and socio-political dimensions of green infrastructure projects, the risk of green elephants cannot be completely avoided. At least in part, the FGCCI may help address the technical dimensions and moral hazard of green elephants due to its unique incentive alignment.

Green investment tools also introduces the risk of “greenwashing” (Sartzetakis, 2021). As early as the Kyoto Protocol, stakeholders were concerned that countries would cover their compliance obligations with surplus “hot air” instead of actual emissions reductions (Boyd & Salzman, 2011; Victor et al., 2001). Similar greenwashing concerns have emerged in recent carbon credit market developments (Boyd & Salzman, 2011; Trouwloon et al., 2023). As investors become more aware of

the benefits of green bonds, there is a green bond premium, known as the “greenium” phenomenon (Liberati & Marinelli, 2021; Caramichael & Rapp, 2022). Therefore, any green bond on par with a conventional bond could capitalize on the premium, creating a potential moral hazard (Sartzetakis, 2021).

By design, the FGCCI should diminish the risk of greenwashing. Carbon credit integration requires rigorous monitoring, reporting, and verification of emissions reductions based on established standards and methodologies (Abadie et al., 2024). New ESG standards and supervisory practices are being developed to foster transparency (Boffo & Patalano, 2020; ICMA, 2021; European Parliament, 2022; ISO, 2022). These standards provide a quantifiable and auditable measure of the environmental impacts, reducing the ability to overstate or misrepresent the “greenness” of the underlying projects (Abadie et al., 2024). Similarly, biodiversity protection initiatives like land conservation and reforestation have clear environmental benefits that are objectively assessable against defined criteria (Freedman et al., 2009; Trouwloon et al., 2023). By explicitly linking a portion of the FGCCI returns to the delivery of verified carbon credits and biodiversity co-benefits, the financial incentives are directly aligned with achieving real, measurable environmental outcomes. The integration of these components enhances transparency by providing clear metrics and reporting requirements that allow investors, civil society, and other stakeholders to independently evaluate the sustainable impacts being generated. While carbon credits and biodiversity protection are not panaceas against greenwashing, they represent objective criteria that can be consistently measured and reported on. By increasing the transparency around the sustainable goals of the FGCCI, the market value of the bond improves and protects investors from greenwashing.

Robust governance frameworks are crucial for ensuring that infrastructure projects of any kind, especially those financed through instruments like the FGCCI, are subjected to stringent scrutiny and uphold the highest standards of transparency and accountability. Many outside structures support the governance of bonds. Governments play a key role by implementing supportive regulations, providing credit guarantees to mitigate investor risks, and allocating budgets for green infrastructure (Banga, 2019). Development banks may facilitate by offering credit enhancements, managing currency hedges, and standardizing certification processes to lower transaction costs (Sartzetakis, 2021).

Success of the FGCCI will depend on tailored solutions that respond to each country’s specific context and policy landscape. With coordinated efforts, green bonds can unlock sustainable financing and enable developing nations to maximize their economic returns while financing their green transition.

5. Conclusion

Investments in green infrastructure in developing economies is crucial for addressing environmental concerns, promoting economic growth, and advancing social equity, particularly in developing economies where sustainability benefits are more pronounced. However, these countries face heightened carbon emission intensities and greater economic constraints, making financing for climate mitigation projects a persistent issue. Despite the urgency of climate action, attracting private capital to these projects remains a complex challenge with few viable solutions due to unique financial risks. The proposed FGCCI bond is a new financial tool to address this issue, focusing specifically on a high-risk subset of investments. This innovative financial mechanism presents a promising policy proposal to fund sustainable infrastructure projects in developing countries. By concentrating on the relationship between risk and investment, we believe combining various risk reduction tools could significantly increase investment without requiring extensive institutional backing. It will allow for greater flexibility to potentially bring more projects to the market.

As demonstrated through the hypothetical case of Country G, FGCCI bonds backed by carbon credits from the protection of biodiversity, future credits from the project, and a floating rate tied to carbon credits, milestones, GDP, and the spillover effect could significantly change the assets and risk profile associated with transitioning a developing country to renewable energy. Critically, the FGCCI framework aligns incentives and ensures accountability throughout the project lifecycle. These features are essential to managing the risk trade-offs inherent in a floating rate structure, protecting the interests of both investors and obligors and upholding the integrity of the green infrastructure developments.

While the FGCCI bond is only one illustrative structure, currently based largely on literature and theoretical work, that can be applied in whole or in part, it exemplifies the potential for financial innovation to overcome existing challenges in financing climate-resilient, low-emissions infrastructure in economies that struggle with attracting investment. We hope this policy proposal inspires ongoing advancements in policy, theory, and financial innovation, and signals the extensive opportunities for sustainable investment instruments to multiply benefits across economic, environmental, and social dimensions. Innovative financial mechanisms are not just beneficial, but necessary to enable a green transition in developing economies and crucial to meet the world's climate ambitions. However, a lack of knowledge, skepticism about the financial viability of green projects, and limited experience with innovative investment tools currently hinder progress. We believe that this paper begins to address these barriers by showcasing how innovative financial mechanisms, such

as FGCCI bonds, can unlock private capital for essential green infrastructure projects in emerging economies.

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