Governing Climate Finance. States, Markets, and Institutional Dynamics in a Low-Carbon Transition.

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Abstract

The mobilization of climate finance is a fundamental challenge in the transition to a low-carbon economy. In this thesis I contribute to the literature that examines the role of institutional design in shaping an effective mobilization of climate finance through three empirical studies and I highlight the challenges of matching public rules, regulations, and practices to climate purpose. Overall, I show the importance of aligning formal rules, market incentives, and information provision to support a greening of finance, and the difficulties in deploying public power to support this form of environmental purpose.

The first paper investigates the impact of the EU Green Bond Standard (GBS) on green bond pricing, arguing that its introduction increased bond yields as investors adjusted to stricter regulatory scrutiny. The findings suggest that firms with weaker environmental reputations faced a "greenwashing premium," while those with strong sustainability credentials experienced minimal market disruption. This study highlights the effectiveness of public regulation in reducing information asymmetry but also reveals short-term costs for issuers. The second paper examines the European Central Bank's (ECB) role in green finance by analyzing the unintended anti-green bias embedded in its collateral framework. Through a comparative analysis of green and conventional bonds, the study finds that the ECB applies higher haircuts to green assets, effectively raising borrowing costs for sustainable projects. This institutional bias, driven by market neutrality principles, challenges the ECB's commitment to climate-aligned monetary policy. The paper study evaluates the World Bank's Maximizing Finance for Development (MFD) framework, which aims to leverage private capital for climate finance in developing economies. This paper finds that MFD disproportionately benefits middle-income countries while failing to mobilize funds for the most climate-vulnerable nations. The results highlight structural constraints in development finance and the limitations of market-driven approaches in addressing global climate inequities.

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Declaration

I declare that this thesis is a presentation of original work and I am the sole author. This work has not previously been presented for a degree or other qualification at this University or elsewhere. All sources are acknowledged as references. As this thesis is comprised of three academic papers, copyrights are in the process, or have been, or will be transferred to the respective publishers.

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Galindo-Gutiérrez, J. Banking against sustainable Finance The effect of the European Central Bank operations on Green Bond prices. **Revise and Resubmit.** *Review of International Political Economy*.

Table of Contents

List of Figures

Main Body

Appendices

List of Tables

Main Body

Appendices

Thesis Introduction

Effective climate transition requires the release of vast flows of financing, with market-based financing providing the bulk of the required resources. Through this thesis, I explore the effectiveness with which public rules, regulations, and practices are facilitating this emergence of market-based climate financing. Through two empirical interventions, I clarify the relationship between public authority and green bond market performance, specifically exploring the impact from ECB 'everyday' market interventions and from the European Union Green Bond Standard. Through a third empirical intervention, I clarify dynamics surrounding the World Bank attempts to catalyze market-based climate finance to developing countries.

Overall, through the thesis, I highlight the challenges of matching public institutions to climate purpose. I show that the ECB's techniques of liquidity management generate unintended negative consequences for green bond performance, as the relative marginality of green bonds within overall financial market operations is translated into additional forms of cost on green bond holders. I show that the World Bank, in a Maximizing Finance for Development program that was intended to push market finance into contexts of greatest needs, is in fact overseeing financing flows toward less climate vulnerable states. Even with the attempted application of progressive public power, market aversion to risk is reproduced as aversion to investing in spaces of higher climate risk and vulnerability. More positively, though, when effective regulatory design and enforcement are combined, market effectiveness can be enhanced. With the EU Green Bond Standard, implemented in 2023, I show that markets have been incentivized and nudged to punish 'greenwashing' across private financing. From these three thematically connected studies, I show the importance of aligning formal rules, market incentives, and information provision to support a greening of finance, and the difficulties in deploying public power to support this form of environmental purpose.

Climate change and environmental degradation caused by increased concentrations of greenhouse gases (GHG) are among the most pressing issues of our time. There is broad consensus that the unprecedentedly high levels of GHGs in the atmosphere are a direct consequence of the industrialization process that began in the late 19th century. As such,

climate change is now widely recognized as human-induced. In its First Assessment Report, the Intergovernmental Panel on Climate Change (IPCC) predicted that rising GHG concentrations would lead to an average global temperature increase of 0.3°C per decade, culminating in a likely rise of 3°C by the end of the century.[1] In response to this threat, the Paris Agreement was adopted in 2015, aiming to limit global warming to 1.5–2°C.

Achieving this goal requires profound changes in current lifestyles and models of production and consumption. The economic system driving these practices must significantly reduce emissions and adapt to the adverse impacts of a changing climate. Decarbonization and other areas of the climate transition, in turn, will require significant amounts of financial resources to achieve this goal. To this end, the United Nations Framework Convention on Climate Change (UNFCCC) defines climate finance as an umbrella term encompassing local, national or transnational financing — drawn from public, private and alternative sources of financing — that seeks to support mitigation and adaptation actions that will address climate change.[2]

Although the existence of a role for private sources of climate finance was acknowledged from the start, in its inception there was an implicit understanding that climate finance would be state-centric, with funds expected to flow primarily through international climate finance institutions (ICFIs), a set of multilateral institutions established to finance efforts to mitigate and adapt to climate change. For instance, the UNFCCC established financial mechanisms accountable to the Conference of the Parties (COP) to facilitate the provision of climate finance and, as such, climate finance was expected to flow through the operating entities of these financial mechanisms. The two largest of these financial mechanisms are the Global Environment Facility (GEF) and the Green Climate Fund (GCF) (Graham & Serdaru, 2020; Pickering et al., 2015). However, recent awareness of the scale of the challenge has underscored the fact that decarbonization will require financial resources considerably more significant than those at the current level of investment. Meeting the Paris Agreement targets and achieving the Sustainable Development Goals (SDGs) will require trillions of dollars annually. For example, the Climate Policy Initiative, an independent research group, estimates that global climate

1 https://www.ipcc.ch/site/assets/uploads/2018/03/ipcc_far_wg_I_full_report.pdf

2 https://unfccc.int/topics/introduction-to-climate-finance#:~:text=Climate%20finance%20refers%20to%20local,that%20will%20address%20climate%20change.

finance needs to increase to about $9 trillion annually by 2030 (CPI, 2023). In the case of emerging markets and developing countries, reports suggest global annual investment needs ranging from $2.4 trillion to $4.7 trillion in annual energy-related investment (IEA & IFC, 2023; OECD, 2020; UNEP, 2022; UNFCCC Standing Committee on Finance, 2022). These figures indicate a significant gap between available and required funding, with demand for ICFI resources far outstripping supply(Green Climate Fund, 2019).
In light of this gap, there have been growing calls to realign the climate finance system to enable the sectoral transitions necessary to address the climate crisis, in which the private sector takes a central role (UNEP, 2022). While the private sector has historically been important, a significant "private turn" has emerged in recent years. This shift seeks to harness national and international capital markets to mobilize private finance in sustainable and climate-related sectors through the promotion of sustainable investments (Tan, 2022). While there is little precision over the scale of investment required from private sector actors, there is a clear assumption that this source will supply a large portion of additional climate finance required.

Although this private turn has longer historical roots (Mawdsley, 2018) it gained momentum with the 2015 Paris Agreement and the UN 2030 Agenda for Sustainable Development. For instance, in April 2021, the Glasgow Financial Alliance for Net Zero (GFANZ) was launched, chaired by Mark Carney, the UN Special Envoy on Climate Action and Finance. GFANZ brings together leading banks and financial corporations to redirect finance toward achieving the COP26 goal of net zero by 2050. Similarly, the World Bank and International Monetary Fund (IMF) have advocated a paradigm shift in development financing, outlined in their "Billions to Trillions" initiative, which calls for leveraging public funding to private sources of funding by providing risk mitigation measures such as guaranteed risk insurance and blended finance (World Bank, 2015, p. 15).

This 'private turn' has been received with skepticism by certain strands of social science scholarship (Christophers, 2024; Gabor, 2021; Mawdsley, 2018; Tan, 2022). Coming from a critical perspective, this scholarship has often viewed global capital markets as detrimental to the public good. Robert Cox, for example, famously critiqued problem-solving approaches to global finance that focus our thinking on how to solve the problems that global capital markets cause from time to time and instead he saw global finance

itself as the problem (Cox, 1994). However, barring significant changes in the global political economy, private capital markets must play a pivotal role in meeting the funding needs of the green transition. This 'private turn' with its focus on domestic and international capital markets and with the aim to 'mobilize' finance has brought politico-economic institutions that were not originally designed with climate finance in mind, and which were not considered in the UNFCCC financial mechanism, into a landscape typically reserved for international climate finance institutions. As such, this turn also introduces new questions and new research avenues.

As a result, the focus of this thesis is twofold. Its primary aim is to look beyond international climate finance institutions and instead focus on a broader range of politico-economic institutions that were not explicitly designed to mobilize climate finance. The environmental political economy scholarship has extensively examined climate institutions. For example, when analyzing developed countries, the literature has directed particular attention to market instruments such as carbon markets (Bailey et al., 2012; Bayer & Aklin, 2020; Calel & Dechezleprêtre, 2016; Genovese, 2021; Michaelowa et al., 2009; Michaelowa et al., 2019; Newell & Paterson, 2010) and carbon pricing (Kim et al., 2016; Lerner et al., 2025; Meckling, 2011). On the other hand, when focusing on emerging and developing economies, the focus tends to be on concessional finance (Eisenstadt et al., 2021; Graham & Serdaru, 2020; Michaelowa & Michaelowa, 2011; Michaelowa et al., 2020).

This literature has expanded our understanding of both the progress made with such instruments and their limitations. However, the challenge of decarbonizing the economy has seen the emergence of new innovative financial instruments such as green bonds and blended finance, which have brought politico-economic institutions center-stage that were not originally designed to mobilize climate finance. The literature has thus far not focused on these dynamics. Given that global environmental governance is currently characterized by its complexity (Keohane & Victor, 2011) and institutional proliferation (Kellerman, 2019), I build on this literature and expand it by focusing on the roles played by traditional institutions such as Central Banks, Regulatory Bodies and Development Banks in using blended finance instruments instead of traditional concessional lending. To this end the thesis consists of three pieces of analysis that helps us understand the politico-economic dynamics of climate finance.

Secondly, the variation in performance shown by the institutions under analysis raises questions about institutional design that are critical to understanding what facilitates or inhibits larger and more efficient flows of climate finance. As such, the second aim of this thesis is to outline a preliminary roadmap of the institutional factors that support effective climate finance performance across different levels and forms, while engaging critically with debates over the tensions between financial systems, the environment, and climate change. I argue that institutions shape the political-economic landscape from which climate finance emerges, and systematic analysis can identify features that enhance flows and capacity for action. This study focuses on the roles of supranational organizations, central banks, and multilateral development banks in influencing climate finance levels, as well as the political dynamics at the party level that create barriers to effective climate finance implementation. In the next section I show how the three case studies under consideration in this thesis illustrate the roadmap to explaining variation in mobilization performance.

Institutional design and mobilization performance

It is often said that climate change is a collective action problem (Barrett, 2003). This holds true in traditional bilateral climate finance and through International Climate Finance Institutions (ICFIs). However, the mobilization of private finance toward sustainable projects faces an additional challenge: information asymmetry. Information asymmetry refers to a situation where one party in a financial transaction possesses more or better information than the other, leading to inefficiencies in the market. While information asymmetry has long been a central issue in financial markets (Lu et al., 2010) climate finance exacerbates this problem by adding layers of uncertainty, particularly around the pricing of climate risks and the potential for greenwashing — the practice of misleading consumers or investors by falsely portraying products, services, or activities as environmentally friendly or sustainable, often to improve a company's image or attract funding (Hyun et al., 2020; Krueger et al., 2020). Consequently, the effectiveness of mobilizing climate finance can be understood as a function of the degree to which information asymmetry or uncertainty is reduced.

Conversely, it is generally accepted that institutions play a critical role in mitigating uncertainty by establishing a stable structure for human interaction and by shaping the incentives for economic, political, and social behavior. In this regard, rational-choice

institutionalism (Acemoğlu & Robinson, 2012; North, 1990) offers a valuable 'off-the-rack' framework for understanding the mobilization of climate finance. Institutions, in this framework, are defined broadly but analytically as formal and informal rules that guide behavior, alongside the mechanisms that enforce these rules. For North, outcomes can be explained by studying institutions because they determine the constraints and incentives for individual and collective actions, thereby shaping long-term economic performance.

North's key insight is that institutions are not limited to formal laws or regulations but also include informal norms and mechanisms of enforcement. Formal rules are clearly defined and officially documented, encompassing laws, constitutions, and organizational mandates that aim to reduce uncertainty by establishing clear expectations for behavior and outcomes (North, 1990, pp. 46-47). Informal rules, on the other hand, include unwritten norms, conventions, and codes of conduct that evolve organically to solve coordination problems. These unwritten rules reduce uncertainty by creating shared understandings that benefit all parties involved (North, 1990, p. 40). Enforcement mechanisms are equally vital as they reduce uncertainty by ensuring adherence to both formal and informal rules. North distinguishes between self-enforcement mechanisms, such as trust and reciprocity, and third-party enforcement, which relies on states, courts, or other institutions to ensure compliance. While self-enforcement can reduce transaction costs in some cases, North emphasizes that third-party enforcement is essential for capturing the full benefits of interactions in a wealth-maximizing world (North, 1990, p. 57). Importantly, North argues that the alignment between formal rules, informal norms, and enforcement mechanisms is a stronger predictor of economic success than the formal rules themselves. Misalignments can lead to inefficiencies, corruption, and stagnation.

Applying North's framework to climate finance suggests that alignment between these factors—formal rules, informal norms, and enforcement mechanisms—should enhance the effective mobilization of climate finance, while misalignments would hinder it. To illustrate this argument, in this thesis I analyze three types of state actors that are central to the financial system but were not originally designed to address climate change: governments, central banks, and development banks. Each of these actors demonstrates different levels of alignment between their formal and informal rules, as well as their enforcement mechanisms, which in turn influence their effectiveness in mobilizing climate finance.

Governments are key actors in green finance because they establish policies and regulations to address externalities associated with public goods like climate change. They shape investments through fiscal tools (such as green procurement), public financing mechanisms (such as grants, loans, and sovereign guarantees), and informational strategies (Whitley et al., 2018). While the term "government" typically refers to national governments, it also includes sub-national and supranational entities.

The European Union (EU) serves as a paradigmatic case study for governments. It demonstrates a strong alignment between its formal and informal rules and enforcement mechanisms, which, in theory, should reduce asymmetry and uncertainty, leading to more effective mobilization of climate finance. Formally, the Treaty of Lisbon mandates the EU to preserve, protect, and improve the quality of the environment, as well as to promote measures to address regional or global environmental problems, including combating climate change.[3] Informally, since the 1990s, the EU has pursued international leadership on climate issues, filling the void left by the United States, which has frequently opposed multilateral climate agreements and famously failed to ratify the Kyoto Protocol (Kelemen & Vogel, 2010). As such, European states, and the EU, have been the predominant focus of research on climate leadership (Oberthür & Dupont, 2021; Tobin et al., 2023; Wurzel et al., 2019). This informal commitment to climate leadership influences the EU's actions even when not formally codified. Finally, the EU possesses robust enforcement mechanisms. EU regulations are legally binding across all member states, and the European Commission monitors compliance. If a member state fails to implement these laws, the Commission can escalate the matter to the Court of Justice of the European Union (CJEU) under Article 17 of the Treaty on European Union. This alignment of formal rules, informal norms, and enforcement mechanisms positions the EU as a leader in mobilizing climate finance.

Central banks, in contrast, face unique challenges in aligning their mandates with climate goals. Traditionally, the primary role of central banks has been to maintain price stability and financial stability. However, climate change poses risks to financial stability, prompting central banks to reconsider their roles in addressing the crisis (Bolton et al., 2020) and central banks have been leading financial policy discussions on climate finance

[3] https://european-union.europa.eu/principles-countries-history/principles-and-values/aims-and-values_en

ever since former Bank of England Governor Mark Carney's landmark speech on climate-related financial risks in 2015.[4]

The European Central Bank (ECB) exemplifies the challenges of aligning formal and informal rules with enforcement mechanisms in the context of climate finance. Under Christine Lagarde's leadership, the ECB informally committed to intensifying its efforts to support the green transition. This includes incorporating climate considerations into corporate bond purchases, limiting the share of carbon-intensive assets that can be pledged as collateral, and promoting transparency to align with the Paris Agreement and EU climate goals (ECB, 2022). However, these climate considerations remain informal and are not part of the ECB's formal mandate, which prioritizes price stability through market neutrality. Market neutrality implies that monetary policy should not favour one sector over another. This formal principle creates tension with informal climate considerations, as prioritizing green assets could violate the neutrality principle. Other major central banks, such as the U.S. Federal Reserve, have avoided incorporating climate considerations for this reason, arguing that such decisions should be left to elected officials (Powell, 2020). This misalignment between the ECB's formal and informal rules, combined with the lack of enforcement mechanisms for climate-related actions, contributes to inefficiencies and biases against green assets, ultimately hindering the effective mobilization of climate finance.

Multilateral development banks (MDBs) provide another critical example. MDBs offer financial and technical support to public and private sectors in developing countries, addressing investment gaps where governments and private entities cannot act. Supported by their shareholders, MDBs have acknowledged their crucial role in tackling global challenges like climate change through initiatives such as green bond programs and integrating climate considerations into their operations.

The World Bank offers a paradigmatic case study of MDBs, revealing a unique form of misalignment. Formally, the World Bank's mission is to end extreme poverty and boost shared prosperity on a livable planet. Climate change considerations are embedded in its formal rules and are prominently displayed at its Washington headquarters. Informally, however, the organization struggles to reconcile its dual role as a development agency

[4] https://www.bankofengland.co.uk/-/media/boe/files/speech/2015/breaking-the-tragedy-of-the-horizon-climate-change-and-financial-stability.pdf

and a bank. The political economy of aid allocation literature highlights the tension between donor interests and recipient needs (Blair et al., 2022; Graham & Serdaru, 2020; Gutner, 2005a; Michaelowa & Michaelowa, 2011; Wade, 1997). As a development agency, the World Bank is expected to prioritize its twin goals of poverty alleviation and sustainability. As a bank, however, it must respond to donor governments' interests and pursue revenue-generating lending opportunities. This dual role often results in selective implementation of mandates, weak compliance with rules, and inconsistent efforts to advance new agendas. The resulting misalignment between the World Bank's formal rules, informal norms, and enforcement mechanisms undermines its ability to mobilize climate finance effectively.

In conclusion, the alignment between formal rules, informal norms, and enforcement mechanisms is a crucial determinant of the effectiveness of climate finance mobilization. The European Union demonstrates how strong alignment across these dimensions can facilitate climate finance. In contrast, the ECB and the World Bank reveal how misalignments can hinder progress, even within institutions committed to addressing climate change. Understanding these dynamics is essential for designing institutions and policies that effectively address the climate crisis. Future research should further explore how these alignments—or misalignments—impact the broader landscape of climate finance, particularly as new actors and mechanisms emerge to meet the growing demand for sustainable investment.

Table 0.1 Summary of the Institutional Design of Case Studies

Case Study	Formal Rules	Informal Rules	Enforcement	Effective Mobilization
European Union	✓	✓	✓	✓
ECB		✓	✓	✕
World Bank	✓		✓	✕

Structure of the dissertation: Synopsis of the three papers.

The dissertation is made of three substantial chapters/papers on interrelated, albeit different, issues regarding the mobilization of climate finance arising from the discussion in the previous section. The first two papers focus on political dynamics that influence green bond pricing. The last one focuses on what international and domestic characteristics influence the flow of private finance into developing countries for sustainable investments.

Paper 1. Public Regulation and the Greenwashing Premium: The Impact of EU Legislation on Sustainable Finance

Paper 1 focuses on the question of whether public regulatory standards can improve mobilization of climate finance by minimizing the risk of corporate greenwashing. Specifically, I investigate the impact of the European Union's Green Bond Standard (EU GBS) on green bond pricing dynamics, focusing on how the new regulation influences investor behavior and mitigates the pervasive issue of greenwashing. Green bonds, designed to finance environmentally sustainable projects, have grown significantly over the past decade. However, their rapid proliferation has also exposed challenges such as inconsistent definitions of "green" and a lack of standardized governance mechanisms, which have allowed issuers to overstate the environmental benefits of their bonds, a practice known as greenwashing. The paper argues that the EU GBS, by providing a unified regulatory framework, has the potential to address these challenges and improve market credibility.

The EU GBS sets out stringent requirements, such as alignment with the EU Taxonomy, mandatory reporting, and external verification. These measures aim to create a more transparent, credible, and comparable green bond market. The paper hypothesizes that the introduction of the EU GBS would result in increased green bond yields, reflecting heightened investor caution and a repricing of bonds to account for reduced information asymmetry. Additionally, the paper theorizes that the effect would be heterogeneous, with issuers perceived as environmental "laggards" facing greater increases in yields than those viewed as environmental "leaders."

To test these hypotheses, I use a Regression Discontinuity in Time (RDiT) design, leveraging the EU GBS announcement in March 2023 as a natural experiment. The analysis focuses on daily green bond yields, which serve as a key indicator of market conditions and investor confidence. The paper further distinguishes between issuers based on their environmental reputation using ESG scores, environmental controversies, and compliance with the EU Taxonomy.

The results confirm the hypotheses, demonstrating that the EU GBS announcement led to a significant increase in green bond yields. Specifically, the yields of bonds issued by environmental laggards rose more sharply than those issued by leaders. This divergence

underscores the role of reputation and credibility in determining investor responses to new regulations. For laggards, the yield increase represents a "greenwashing premium," where investors demand higher returns to compensate for the perceived risk of holding assets that may not fully comply with the EU's stringent criteria. In contrast, bonds issued by environmental leaders experienced a smaller increase in yields, as these issuers already enjoyed higher credibility in the market.

The findings have important implications for policymakers, investors, and issuers. For policymakers, the results highlight the value of credible and unified regulatory standards in reducing greenwashing and enhancing market integrity. By setting clear rules and enforcing transparency, the EU GBS can help strengthen investor confidence and promote sustainable finance. For investors, the study underscores the importance of critically assessing environmental claims and prioritizing bonds certified under rigorous public standards. For issuers, the findings suggest that aligning with credible frameworks like the EU GBS can help mitigate risks associated with higher yields and improve access to the growing pool of green capital.

The paper also raises broader questions about the long-term effects of the EU GBS. While the short-term market reaction has been characterized by increased yields and investor caution, I argue that these adjustments could pave the way for a more robust green bond market. Over time, the EU GBS may incentivize environmental laggards to improve their practices to compete with leaders, fostering a bifurcated market where truly green issuers command a premium. Drawing on theories such as the "California effect" and the Porter Hypothesis, the paper suggests that stringent regulations can drive innovation and elevate environmental standards across industries.

In conclusion, the EU GBS represents a significant step toward addressing greenwashing and creating a more credible and transparent green bond market. While the initial effects include higher borrowing costs, particularly for environmental laggards, the long-term benefits could include a more sustainable financial ecosystem and greater alignment with global climate goals.

Paper 2. Banking against sustainable finance. The effect of the European Central Bank on Green Bonds.

My second paper explores how the European Central Bank's (ECB) collateral framework influences green bond pricing, highlighting unintended consequences for sustainable finance. It identifies a systematic "anti-green bias" embedded in the ECB's valuation of green bonds relative to conventional bonds. This bias, reflected through more conservative "haircuts" — discounts applied to the valuation of bonds pledged as collateral — for green bonds, results in higher borrowing costs for green bond issuers, thereby undermining their ability to secure funding for environmentally sustainable projects. The findings raise questions about the ECB's alignment with the climate goals outlined in the Paris Agreement, particularly given its commitment to integrating climate considerations into its policies.

In this paper, I examine the role of central banks as market actors capable of influencing bond yields and borrowing costs across the financial system. Through the Eurosystem Collateral Framework, the ECB assesses bond risk via haircuts. Haircuts determine the liquidity and attractiveness of bonds, as assets with lower haircuts can be used to access central bank credit more efficiently. However, the study reveals that the ECB applies higher haircuts to green bonds compared to conventional ones, effectively offsetting the "greenium," or cost advantage typically associated with green bonds in the market.

Using a matched-sample methodology, I identify green and conventional bonds that are otherwise identical in characteristics like maturity, coupon rates, and credit ratings in order to evaluate the treatment effect that the green label has on its prices using a standard Two-Way Fixed Effects regression. This approach isolates the effect of the ECB's policy on bond pricing. The results confirm that green bonds face more stringent haircuts, leading to higher yield spreads between green and conventional bonds. Specifically, a 1% increase in haircut spreads translates into a 2.7 basis point rise in green bond yields, reducing their competitiveness and hindering their potential to mobilize additional funding for green projects.

I distinguish between two forms of bias within the ECB's framework: carbon bias, where carbon-intensive assets are favored due to market neutrality policies, and anti-green bias, where green bonds are treated unfavorably despite their environmental benefits. While

existing literature has extensively discussed the ECB's carbon bias, I highlight the distinct and underexplored issue of anti-green bias. The findings suggest that even as the ECB prioritizes climate considerations, its current operational practices inadvertently penalize green finance.

The implications of these results extend to both policymakers and financial markets. I conclude by highlighting the potential for reforms to the ECB's collateral framework to eliminate the anti-green bias and support the transition to a low-carbon economy. Potential measures include recalibrating haircut values to account for climate risks and enhancing the liquidity of green bonds in secondary markets. Additionally, I emphasize the importance of integrating climate considerations into monetary policy operations beyond market neutrality, arguing that central banks must actively promote green assets to align with global sustainability goals.

In conclusion, I underscore the critical role of central banks in shaping sustainable finance and call for further empirical research to understand how state agencies influence green bond markets. By addressing the anti-green bias within its framework, the ECB can enhance the efficacy of green bonds as tools for financing climate action and contribute more effectively to achieving the objectives of the Paris Agreement.

In this paper, I offer one of the first comprehensive empirical studies of how central banks' monetary policy affects green bond prices. As such I contribute to the literature on green bond prices, which has thus far focused exclusively on the financial characteristics of the bonds. This paper helps answer the research question by exploring how central banks' policies have created an additional barrier to the effective mobilization of private finance.

Paper 3. The World Bank and 'Maximizing Finance for Development': talk the talk but not walk the walk.

The final chapter looks at those left behind by the market, namely, developing countries and also looks at financial instruments beyond green bonds. While green bonds are considered the principal asset class through which to raise private capital to finance the fight against climate change and are seen as the successors of the Clean Development Mechanism in the governance of climate change (Bracking, 2015), developing countries face several institutional and market barriers to accessing green bond markets (Banga,

2019). As such multilateral development banks (MDBs) are crucial for addressing the mitigation and adaptation needs of developing countries (Brunner & Enting, 2014; Mazzucato & Penna, 2016). As such, this paper asks whether the World Bank can mobilize private finance effectively to developing countries to support climate change transition.

Here I argue that while the MFD represents an ambitious shift toward leveraging private sector resources, my research reveals that it falls short of addressing the needs of the most vulnerable populations. The central argument of my paper is that the MFD's market-driven approach is inherently biased toward middle-income countries with stronger financial systems, leaving low-income nations—which often face the greatest climate risks—behind. This systemic misalignment undermines the World Bank's dual mandate to act as both a financial institution and a development agency. By employing Qualitative Comparative Analysis (QCA), I identify causal pathways that determine a country's eligibility and engagement with the MFD. Key factors include governance quality, economic development, and financial sector maturity, while high debt levels and extreme climate vulnerability deter participation.

My empirical findings highlight how MFD disproportionately benefits wealthier nations, as private investors are more likely to fund projects in stable environments with predictable returns. In contrast, countries with fragile economies or governance structures struggle to attract private finance, even with the World Bank's risk-sharing instruments. I also underscore a critical design flaw in the initiative: its inability to reconcile the divergent interests of donor states, private investors, and recipient countries. This challenge is especially evident in sectors like renewable energy and infrastructure, where public funds often de-risk private investments rather than directly addressing developmental needs.

Additionally, I highlight the MFD's departure from traditional concessional financing, which has historically been effective in targeting the poorest and most climate-vulnerable nations. Furthermore, by prioritizing market-based mechanisms, the MFD risks undermining the principle of "common but differentiated responsibilities," a cornerstone of international climate justice.

In conclusion, my paper engages with the broader discourse on the role of international financial institutions in global climate governance. By identifying and addressing the systemic biases inherent in the MFD initiative, I provide actionable insights for policymakers seeking to bridge the gap between financial markets and developmental imperatives. Ultimately, this work underscores the importance of equitable financing solutions to ensure that no nation is left behind in the fight against climate change.

Methodology

As described in the previous section, this thesis consists of three papers on interrelated, albeit different, issues regarding the mobilization of climate finance. Given that each paper addresses a different question, it is crucial that the methodology of each paper reflects on the aim and purpose of each question. In this section I elaborate on the logic underpinning each methodological choice.

In this thesis, I employ a methodological pluralist approach, recognizing that the different aspects of the research question require different methods to answer them effectively and that no method is universally applicable to all situations. As such, I employ both large-n and medium-n analyses to identify causal effects with the appropriate strategy.

This thesis adopts a quantitative and comparative institutional approach to identify generalizable patterns across multiple actors and contexts. While qualitative interviews with ECB officials or private financiers could yield rich insights, they were not pursued due to access limitations and the thesis's emphasis on institutional and regulatory design. In a sense, I adopted the quantitative approach to 'circumnavigate' the lack of access. Future research could build on these findings by incorporating elite interviews to better understand decision-making logics behind haircut policy or regulatory announcements.

In the first paper, I use a regression discontinuity in time (RDiT) approach. According to Lee and Lemieux, the use of regression discontinuity designs has expanded rapidly for two main reasons: first, they require mild assumptions compared to those needed for other nonexperimental approaches; and second, a belief that causal inferences from RD designs are potentially more credible than those from typical "natural experiment" strategies (Lee & Lemieux, 2010). As a special case of such designs in which the running variable is a measure of time, RDiT designs have become especially useful in environmental

economics, where daily or even hourly data are readily available (Hausman & Rapson, 2018).

In the second paper, I rely on a version of Two-Way Fixed Effects (TWFE). Here, I am interested in estimating the treatment effect of ECB monetary policy on labeled green bonds in contrast to conventional bonds. However, several practical barriers prevent a straightforward approach. First, the significant difference in the number of conventional versus green bonds leads to an imbalance in covariates, which, in turn, results in inefficient estimations of causal effects and greater model dependence (King & Nielsen, 2019). Second, recent literature notes that TWFE estimators are inefficient when there are treatment effect dynamics—namely, if the effect of participating in the treatment varies across time periods or with the length of exposure to the treatment (Imai et al., 2023; Sun & Abraham, 2021). Finally, practical barriers prevent the collection of data through experimental design.

To circumvent some of these issues, I pre-process the data by matching observations to their nearest neighbor. By "pruning" observations that lack close matches on covariates in both the control and treated groups, we can ensure that estimating the Average Treatment Effect on the Treated (ATT) is less influenced by modeling decisions. Matching methods help identify "hidden randomized experiments" within an observational dataset to estimate causal effects (King & Nielsen, 2019). After pre-processing, I proceed with TWFE analysis to estimate the treatment effect of ECB monetary policy, combining matching with TWFE to address imbalance and dynamic treatment effects while retaining the strengths of fixed-effects estimation to control for any unobserved heterogeneity.

In the final paper, I use fuzzy set qualitative comparative analysis (fsQCA) to examine the contextual and climatic variables that affect a country's engagement with private capital mobilization under the Maximizing Finance for Development framework. The use of fsQCA is justified because the number of cases does not allow for robust multivariable regression analysis and because fsQCA accommodates equifinality—the idea that multiple combinations of conditions (or "causal recipes") may lead to the same outcome (Ragin, 2008, p. 54). Given the heterogeneity of case studies, this approach is justified. Unlike statistical approaches, which identify the net effects of independent variables while holding all other variables constant, fsQCA explores the interplay of conditions that

inform an outcome. Built upon Boolean algebra, fsQCA assigns scores from 0 (non-membership in a set) to 1 (full membership in a set) for individual cases. It identifies causal configurations leading to an outcome using Boolean principles, where “AND” represents conjunction, “OR” denotes disjunction, and “NOT” indicates negation.

Contributions of the Thesis

The challenge of decarbonizing the economy has spurred the emergence of innovative financial instruments, such as green bonds and blended finance. These instruments have, in turn, brought new politico-economic institutions to the forefront—institutions that were not originally designed to mobilize climate finance. While the literature has explored the role of explicitly climate-focused institutions, it has largely overlooked the influence of broader political and economic institutions on climate financing outcomes. This thesis addresses this gap by examining how these "non-climate" institutions play a pivotal role in shaping climate finance dynamics. In this thesis I add to this scholarship in several ways.

First, this thesis takes a novel approach by shifting the focus away from institutions explicitly designed to govern climate outcomes. Instead, I examine how broader political and economic institutions—those not traditionally associated with climate governance—exert significant influence on climate financing outcomes. In contrast to existing work, I argue that these “non-climate” institutions can, in many cases, be more consequential for climate finance than formal climate institutions. For instance, regulatory bodies, development banks, or central banks that were not initially created with environmental considerations in mind are now key actors in mobilizing and directing climate finance. My analysis thus reveals that the boundaries of climate governance extend beyond the obvious, and the most effective climate institutions may not always be those designed for climate at all.

Secondly, this thesis contributes to the literature on environmental regulation and green finance by empirically and theoretically examining the impact of the EU Green Bond Standard (EU GBS). Theoretically, by engaging with existing scholarship on information asymmetry and private versus public governance initiatives, this thesis argues that public regulatory standards such as the EU GBS play a pivotal role in reducing greenwashing risks. While private initiatives often preempt stricter public regulations, the variation in

criteria and participants in private markets creates vulnerabilities. This research highlights that given their credibility, public standards can, in theory, offer a more reliable mechanism for fostering transparency and mitigating asymmetries in green finance. In addition to this, I engage theoretically with literature that suggests that well-designed environmental regulations stimulate innovation which, by enhancing productivity, increases firms' private benefits such as the California Effect or the Porter Hypothesis. By showing that the introduction of the EU Green Bond Standard may have a negative effect in the short term for bond issuers, it engages theoretically with this literature by suggesting that this effect has the potential to generate long-term positive effects on the green bond market. By raising the bar for what qualifies as a green bond, the EU regulation could drive a global "trading up" of environmental standards, particularly among firms looking to tap into the growing demand for sustainable investments.

Empirically, I contribute to the scholarship by demonstrating that the introduction of the EU GBS had a tangible impact on green bond pricing dynamics, leading to a significant increase in green bond yields. This finding reveals how the introduction of a credible and stringent regulatory framework influences investor behavior by fostering greater scrutiny and caution in markets characterized by high information asymmetry. These results provide critical insights into how regulatory interventions can reshape green bond markets and their implications for corporate environmental practices.

Thirdly, the thesis advances the literature on the political economy of central banking and its intersection with climate finance by elucidating the unintended consequences of ECB policy interventions.

In this sense I contribute theoretically to the debate by introducing the distinction between "carbon bias" and "anti-green bias" in the ECB's operations. While carbon bias reflects the favorable treatment of carbon-intensive assets, anti-green bias denotes the systematic undervaluation of green bonds simply because of their labeling. This conceptual differentiation not only provides a nuanced understanding of the ECB’s role but also offers actionable insights into how the ECB can align its practices with the goals of the Paris Agreement.

Empirically my research addresses a critical gap in the literature by investigating how central bank policies, specifically the ECB's collateral framework and valuation practices,

influence green bond pricing. While existing studies focus predominantly on intrinsic bond features such as maturity and credit ratings, this analysis highlights the wider politico-economic factors, particularly the impact of policy-induced distortions. By doing so, this thesis underscores how institutions like central banks indirectly shape green finance markets.

Thirdly, my research engages with the scholarship that addresses the evolving role of the World Bank in mobilizing private finance for climate adaptation and mitigation, contrasting it with its historical effectiveness as a lender of concessional finance.

Theoretically, I argue that blended finance instruments in the Maximizing Finance for Development agenda are an attempt by the bank to "square the circle" and reconcile its dual identity as a development agency and a financial institution. Furthermore, the research contributes to understanding institutional dynamics by identifying factors that determine a country's "MFD readiness" and conditions that discourage the use of private capital mobilization, such as high debt levels and weak governance.

Empirically, the findings suggest that this strategy, as embodied in the MFD agenda, fails to "square the circle," as it prioritizes financial mobilization over development needs. As such, I add to the scholarship by identifying the limitations of the Bank's risk-sharing instruments in attracting private investment to high-risk climate adaptation projects in vulnerable countries. By comparing these dynamics with the Bank's prior success in public finance-based operations, the thesis highlights the inadequacy of the MFD framework in addressing the needs of the poorest and most at-risk nations. This work also extends comparative climate policy literature by analyzing patterns of climate policy adoption in developing countries, which remain understudied

Finally, the thesis provides a roadmap for understanding the institutional dynamics that either enable or hinder effective climate finance mobilization. By comparing the European Union (EU), the European Central Bank (ECB), and the World Bank (WB), the analysis highlights critical variations in institutional design and performance. Taken together these case studies hint at how institutional misalignments —between formal rules, informal norms, and enforcement mechanisms— contribute to inefficiencies in mobilizing climate finance. For instance, the EU's strong alignment of these elements positions it as a leader in climate finance mobilization. Conversely, misalignments within

the ECB (e.g., between its market-neutrality principle and informal climate considerations) and the WB (e.g., its tension between development and financial priorities) reveal barriers to effective climate action. These comparative insights provide actionable lessons for designing institutions capable of mobilizing larger and more efficient flows of climate finance.

Paper 1

1 Public Regulation and the Greenwashing Premium: The Impact of EU Legislation on Sustainable Finance.

Abstract

Corporate greenwashing undermines the credibility of sustainable finance, where deceptive environmental claims jeopardize the allocation of funds to truly impactful initiatives. The European Union's Green Bond Standard (EU GBS) seeks to combat this by introducing stringent criteria for green bond issuance, including alignment with the EU Sustainability Taxonomy, mandatory reporting, and external verification. This paper examines the immediate impact of the EU GBS on the green bond market, with a specific focus on pricing dynamics and the effect on issuers with varying environmental reputations. Using a regression discontinuity in time (RDiT) design, I analyze green bond yield data from February 2022 to May 2023, leveraging the EU GBS's announcement as a natural experiment. My findings reveal a 19 basis point increase in green bond yields following the announcement, reflecting investor caution amid heightened regulatory scrutiny. However, the impact is not uniform: issuers with stronger environmental reputations experienced smaller yield increases, while those perceived as environmental laggards faced higher penalties, indicative of a "credibility gap" in the market. This differentiation highlights the role of public regulation in enhancing transparency and accountability in sustainable finance. The analysis underscores the EU's leadership in climate policy and its capacity to shape global market behavior. By addressing greenwashing, the EU GBS provides investors with greater confidence, promoting a shift toward more informed and responsible investment practices. The results also contribute to the broader literature on the interplay between public regulation and market-based governance, demonstrating how unified standards can reduce information asymmetry and encourage issuers to improve their environmental performance. Beyond the immediate market response, the paper explores the potential long-term effects of the EU GBS. While the initial increase in bond yields signals stricter investor scrutiny, this shift may pave the way for a more nuanced and credible green bond market. Issuers with robust environmental credentials could benefit from a "greenium," whereas laggards may face diminishing market access unless they adopt more sustainable practices. This dynamic aligns with theories like the "California effect" and the Porter Hypothesis, which suggest that stringent regulations can drive higher environmental standards and innovation among firms. In conclusion, the EU GBS demonstrates the transformative potential of public regulation in sustainable finance. By curbing greenwashing and fostering accountability, the standard not only enhances the credibility of green bonds but also contributes to global efforts to finance the transition to a sustainable economy.

1.1 Introduction

The emergence of green bonds as a financial instrument designed to fund environmentally sustainable projects marked a significant shift in global capital markets. Over the past decade, the green bond market has experienced exponential growth, driven by increasing investor demand for sustainable finance and the growing urgency of addressing climate change. However, this rapid expansion has also exposed the market to critical challenges, most notably the issue of greenwashing—where issuers overstate the environmental benefits of their bonds. The absence of standards that are universally accepted and enforced has led to a heterogeneous market where the credibility of green bonds varies widely, creating information asymmetry that can undermine investor confidence.

Amidst this backdrop, the European Union (EU) introduced its Green Bond Standard (EU GBS), a regulatory framework aimed at enhancing transparency, credibility, and comparability in the green bond market. The EU GBS sets out stringent criteria for what qualifies as a green bond, including alignment with the EU Sustainability Taxonomy, mandatory re- porting, and external verification. As the EU is a significant player in global finance and a leader in climate policy, the introduction of this standard is poised to have a substantial impact on the global green bond market.

This paper seeks to explore the impact of the EU GBS on green bond pricing dynamics, particularly focusing on how the new standard influences bond yields—a key indicator of investor confidence and market conditions. Given the market's heterogeneity and the prevalent problem of greenwashing, the introduction of a unified standard by a credible entity like the EU is expected to alter investor behavior. Specifically, the paper hypothesizes that the EU GBS will lead to an overall increase in green bond yields as investors become more cautious and therefore ask for a higher return of their investment in the face of the uncertainty that the EU standard brings, reflecting heightened scrutiny over the environmental credentials of issuers.

To test these hypotheses, the paper employs a Regression Discontinuity in Time (RDiT) desiign, leveraging the EU GBS's announcement as a natural experiment. The study analyzes daily yields of green bonds from February 2022 to May 2023, examining how yields reacted to the announcement of the EU GBS. The analysis also investigates the heterogeneity of these effects, focusing on bonds with and without external verification, as well as issuers classified as environmental leaders or laggards based on ESG scores

and controversy indica- tors. My findings suggest that investors are applying a "greenwashing premium". Where a green bond issuer has stronger environmental credentials, there is little market adjustment following the introduction of the EU's more stringent criteria for certification. Where a green bond issuer has weaker environmental credentials, a credibility gap premium is applied to cover for the danger of holding an asset that may fall foul of the new public regulation.

The findings of this research contribute to the ongoing debate on the effectiveness of regulatory standards in green finance. In particular, it speaks to the work that seeks to explain the interaction between politico-economic effects of environmental regulation and the firm-level characteristics that shape the heterogeneity of these effects (Bayer, 2023; Bechtel et al., 2019; Brulle, 2021; Cheon & Urpelainen, 2013; Distelhorst & Locke, 2018; Genovese & Tvinnereim, 2019; Kelsey, 2018; Kennard, 2020; Kim et al., 2016; Lerner & Osgood, 2023; Meckling, 2015; Monogan III et al., 2017). By providing empirical evidence on the impact of the EU GBS, this paper not only sheds light on the immediate consequences for green bond yields but also offers insights into the broader implications for market behavior and corporate environmental practices.

Secondly, it engages, more broadly, with the robust literature in environmental politics that addresses EU environmental leadership (Oberthür & Dupont, 2021; Tobin et al., 2023; Vogel, 2003; Wurzel et al., 2019) by showing how the credibility of the EU as a climate leader can be used as a signaling tool by bond issuers to avoid criticisms of greenwashing. Particularly, while there is robust evidence within this literature regarding the long-term impacts of EU policies, evidence that examines the short-term effects of such policies is rare (Bechtel & Schneider, 2010). By looking at the immediate market response to the EU GBS, I contribute to this debate. Ultimately, this research underscores the critical role of credible regulation in fostering a more transparent and reliable green bond market, which is essential for mobilizing the capital needed to address global environmental challenges.

This paper is structured to provide a comprehensive analysis of the impact of the EU Green Bond Standard on green bond pricing dynamics. First, I develop the theoretical framework, outlining the main hypotheses regarding how the new EU standard might influence green bond yields and the behavior of investors, particularly in the context of external verification and issuer environmental reputation. Then, I detail the empirical

approach, including the dataset and the regression discontinuity in time (RDiT) design used to estimate the causal impact of the EU legislation on green bond yields. The next section presents the results of the impact of the EU Green Bond Standard on green bond yields and explores the heterogeneous effects of external verification and issuer environmental reputation on green bond pricing, offering insights into how these factors interact with the new regulatory framework. Finally, I address how these negative short-term effects might be temporary and lead to a greening of the financial markets in the long run, before concluding by summarizing the key findings, discussing their implications for green bond markets and regulatory practices, and suggesting avenues for future research.

1.2 A Theory of the impact of environmental leadership on an asymmetric market

As the demand for sustainable and environmentally responsible investments grows, the green bond market has emerged as a pivotal tool for financing projects aimed at addressing climate change and promoting environmental sustainability. However, the rapid expansion of this market has also brought about challenges, particularly the risk of greenwashing. In this paper, I address how public regulation can limit the risk of greenwashing in the green bond market. I develop my theory in two steps. First, I argue that – despite evidence suggesting that public regulation could be crowded out in the context of a well-established system of private regulation – the segmentation and heterogeneity of market-based governance cannot effectively regulate greenwashing given persistent issues with information asymmetry. As such, I propose that a systematic and unified standard, established by a public institution, can mitigate greenwashing by encouraging more conservative behavior among investors. Additionally, I theorize that the effects of such regulation will not be homogeneous, impacting firms perceived as environmental laggards more significantly.

Traditionally, "greenwashing" consists of companies making false or exaggerated claims about the environmental soundness of their products by selectively disclosing information about their environmental credentials, without fully disclosing any negative information in order to construct a positive environmental image (Lyon & Maxwell, 2011). In the context of green bonds, companies may label projects that are not environmentally sound or 'green' as compliant with green bond requirements by providing deceptive information about the use of proceeds of the bond during the issuance process.

Since the issuance of the first green bonds in 2007, several green bonds have been criticized for engaging in corporate greenwashing. For instance, in 2017, Repsol, a Spanish oil and gas company, issued a green bond to finance and refinance energy efficiency investment in their chemical and refinery facilities to reduce greenhouse gas emissions. While the goal of the bond was to reduce emissions, critics argued that it would lead to an indirect increase in emissions over time as it would extend its plants' lifetimes (CBI, 2017). In 2016, Mexico City issued a green bond to finance the construction of a new airport which faced criticism for its overall environmental impact, including the destruction of a unique ecosystem and high carbon emissions associated with its construction (Gonçalves, 2021).

The potential for greenwashing is increased by the fact that, until recently, there was no single global definition of what a green bond is and no standardized supervision mechanism that ensures that bond proceeds are effectively funding green projects. Instead, governance of green bonds is largely decentralized and conducted by a variety of market institutions and investment standards, such as the Green Bond Principles, the Climate Bonds Initiative certification scheme, and third-party verification of individual green bonds. Notably absent from this governance regime are state institutions and government regulation. In this sense, a public regulatory framework could have a significant impact in the green bond market by establishing clear, enforceable and uniform standards and ensuring transparency and accountability in the green bond market.

Nonetheless, given that public governance is a late comer, we could also expect that a public regulatory framework could result in nothing more than 'hot air' as preceding private governance regimes may compete with public regulators to be adopted by market participants (Park, 2018). In this regard, there is a robust strand of research that suggests that private governance initiatives and regulations can serve as a political strategy to preempt more stringent public regulations by crowding out the demand for governmental interventions (Kolcava et al., 2021; Lyon & Maxwell, 2004; Malhotra et al., 2019; Potoski & Prakash, 2013; Rhein & Sträter, 2021).

For instance, Potoski and Prakash (2013) argue that several voluntary environmental programs (VEPs) can be aptly described as "greenwashes" because they impose no real obligations on their participants and yet convey an impression of environmental stewardship. As such, they agree with the literature that argues that VEPs are not tools

for addressing environmental problems but instead are strategic devices employed by firms. Moreover, empirical work reaches similar conclusions. For example, Malhotra et al. (2019) conduct a survey experiment to investigate whether VEPs would decrease, increase, or have no effect on support for government regulations, and find that companies can reduce sup- port for environmental regulations by voluntarily doing more than the status quo, but less than what people might demand in the absence of self-regulation. Kolcava et al. (2021) reach similar conclusions in the case of a survey experiment in Switzerland and add that external (i.e. third party) oversight increases the reputational stakes of firms that engage in voluntary measures, which in turn reduces support for government regulation. Rhein and Sträter (2021) argue that companies implement voluntary recycling strategies as a way to manage plastic waste and reduce environmental impacts in order to avoid altering their production and consumption patterns as this lets them talk about supporting a circular economy while, in reality, implementing a recycling economy. Finally, private governance can serve an analogous purpose to what Lyon and Maxwell (2004) famously called "astroturf lobbying" which involves the provision of soft information targeted at public decision makers to influence policy decisions or sway public perception of their environmental practices or policies. For instance, a company facing scrutiny over its environmental record might launch an astroturf campaign to portray itself as a leader in sustainability, thereby deflecting criticism or regulatory scrutiny.

Theoretically, therefore, we could expect a public regulatory initiative to have a limited impact given that it would compete with a well-established private regulatory framework. Indeed, such arguments help explain why the European Commission came to the conclusion that the introduction of a European credit rating agency would add little value to investors given the information already existing (EPRS, 2016). Nonetheless, as I will argue, the fragmented and pluralistic nature of the private regulatory framework that exists creates a situation where information asymmetry is present and, as such, poses several kinds of legitimacy challenges. This fact, coupled with the need for investors to satisfy demand for true green assets (Guerrero-Villegas et al., 2018; Muñoz-Torres et al., 2019; Ortas et al., 2019) opens the possibility for a public governance initiative to have a significant impact in the green bond market by effectively reducing the space for greenwashing.

Governing green bonds through markets: information asymmetry and legitimacy.

As I mentioned previously, green bond governance is fragmented as there is no single global definition of what a green bond is and no standardized supervision mechanism that ensures that bond proceeds are effectively funding green projects. As a result, the authenticity of a green bond is a function of invisible characteristics subject to asymmetric information, a situation where the parties involved in the market possess unequal levels of information (Bachelet et al., 2019, p. 4).

Information asymmetry has always been a key issue in bond markets. For instance, it has been shown that the level of information asymmetry on credit risk is related to bond liquidity (Copeland & Galai, 1983; Glosten & Milgrom, 1985), and bond pricing (Khalil et al., 2019; Krueger et al., 2020; Lu et al., 2010). But unlike credit risk where there is a prevailing credit rating practice, green bonds add an additional level of asymmetry by having to assure potential investors of their green credentials (Hyun et al., 2020). In this respect, Cartellier et al. (2024) use a general equilibrium model to show that greenwashing can be mitigated by enhancing transparency to reduce information asymmetry.

Thus, reducing the information asymmetry of a bond's "greenness" is crucial for green bonds, especially considering that green bonds generally trade at a premium or "greenium", resulting in a reduced cost of borrowing relative to equivalent conventional bonds (Zerbib, 2019). As such, it has been theorized that for green bonds to be effective they need to address the challenge posed by this case of information asymmetry because if bonds that are not truly green can claim the benefits of greenium without any added costs, green bonds would lose their credibility (Schmittman & Gao, 2022).

To address these challenges, issuers of green bonds can disclose certain information – such as how proceeds are allocated or the level of environmental outcomes – to increase transparency for the purpose of signaling the issuer's environmental commitments to potential investors, nonetheless credibility remains a concern (Clarkson et al., 2019). To circumvent this credibility barrier bond issuers have increasingly relied on verification by independent third parties to enhance their signaling communications with the relevant groups (Ehlers & Packer, 2017; Simeth, 2022). Of these independent reviews, second-party opinions (SPOs) issued by an independent research institution such as CICERO

(recently bought by S&P), ISS-Oekom, Vigeo Eiris, Moody's, and Sustainalytics, are the most popular (Dinh et al., 2023; Dorfleitner et al., 2022). As such, the financial economics literature has increasingly focused on the impact of SPOs on green bond prices.

While there are some studies that find no significant relationship between external verification and green bond prices (Zirek & Unsal, 2023), the majority of studies find that a credible and independent review is valuable to investors as a means of reducing information asymmetry regarding greenwashing as they are more willing to accept lower interest rates (i.e. returns) on green bonds with verification than those without relative to similar conventional bonds (Dorfleitner et al., 2022; Flammer, 2021; Hyun et al., 2020; Simeth, 2022). Nonetheless, while external verification can help reduce information asymmetry and mitigate concerns about greenwashing, its effectiveness is limited by the fact that different market institutions and participants compete for market adoption with varying definitions of what constitutes a green bond. For example, while many SPO providers only provide a binary qualification for bonds that rates them as being either green or not green, others provide a qualitative guide of the 'true greenness' of green bonds (for example, CICERO grades bonds into 'shades of green' indicating the potential environmental impact of the bond) (Dorfleitner et al., 2022). Moreover, the lack of harmonized rules for reviewing green bonds and diverging definitions of green activities make it difficult for investors to effectively compare bonds with respect to their environmental objectives. Theoretically, then, the lack of unified standards may undermine the reliability of certification and can lead to green bond issuers engaging in green window dressing. Famously, both the Repsol and Mexico City Airport green bonds had been externally verified by SPOs.

Alternatively, empirical work looking at the characteristics of firms that ask for verification services have found that a firms that has a poor environmental reputation is more likely than a firm with good reputation to ask for assurance services to enhance their reputation (Dinh et al., 2023; Hummel et al., 2019). Intuitively, if a firm has a strong environmental reputation, it would not seek external verification as it already considers itself a legitimate green bond issuer; conversely, firms that are poor environmental performers might require an external actor in order to look greener (backdoor greenwashing).

Given this segmentation and lack of consistency, critics suggest that governing green bonds through market institutions is challenging as they lack legitimacy as this fragmentation leads to incoherent or conflicting regulatory mandates and uncertainty among market participants. Moreover, since, as a general rule, private governance standards do not have the same enforcement mechanisms as public regulation, which can draw on the coercive authority of government, they also lack accountability (Park, 2018). Furthermore, the broader literature on private sector certification has highlighted the limited capacity of such schemes to produce substantive change. These initiatives often function more as tools for "checklist compliance" than as meaningful regulatory mechanisms (Locke, 2013), or they may be inadequate in 7 low-governance contexts, where they are unable to 'fill the void' in the absence of robust institutional frameworks with standards of best practice (Bartley, 2018). For investors relying on private certification as a guideline of environmental performance, this raises questions about the greenwashing potential and informational value of such labels.

This last point is important given that recent literature suggests that investors, especially those with ESG mandates, face scrutiny and reputational risk over the environmental legitimacy of their portfolios (Starks, Venkat, and Zhu 2017). Furthermore, survey evidence indicates that green bond purchases are influenced by the environmental credentials at issuance and post-issuance performance, reflecting investor preferences that are not purely pecuniary but reputational (Sangiorgi & Schopohl, 2021). In this sense, credibility operates as a reputational filter: institutional investors aim to avoid holding assets that may later be revealed as greenwashed, as this could undermine their own reputation with their clients. This logic builds on earlier work on ethical investing and portfolio exclusion (Heinkel et al., 2001), and on Fama and French (2007) challenge to the classic view of investor rationality as solely return-driven.

Governing green bonds through state institutions: Climate leadership and the EU Taxonomy

Given this background of market heterogeneity and lack of legitimacy, a public and unified standard has the potential to have a significant impact on the green bond market. As such, within the broader context of the European Green Deal – the EU's overarching

strategy to become climate-neutral by 2050 – in February 2023 the European Parliament and the European Council agreed on a proposal for a European Green Bond Standard.

First, this initiative addresses the issue of legitimacy as the European Union has a long-established history of environmental leadership and, specifically, the European Green Deal enabled the EU to increase its sway on the international stage (Tobin et al., 2023; Wurzel et al., 2019, p. 7). Secondly, the EU green bond standard addresses the segmentation in the green bond market by linking it with the EU taxonomy, a regulatory framework that clarifies what constitutes sustainable activities and what it means for transition, thus making it easier to identify what is a green project. The Taxonomy translates EU policy commitments for use by capital markets. As such, it bridges the gap between policy and investment practice by signaling which projects are consistent with its environmental objectives. Specifically, bonds certified under the EU green bond standard would need to ensure that at least 85% of the use of proceeds of the bond are allocated to economic activities aligned with the EU Taxonomy. In practice, this means that they need to contribute substantially to at least one of the environmental objectives of the taxonomy, they must comply with the no-harm rule so as not to significantly harm any of these objectives, they must comply with minimum safeguards and they must comply with technical screening criteria.5 Crucially, it also establishes the supervision of issuers by instituting mandatory ex post verification of allocating reporting where firms are required to submit yearly reports demonstrating that the proceeds of the European Green Bond, from its issuance date until the end of the period referred to in the report, have been allocated in accordance with the regulation during the lifetime of the bond (EU TEG, 2020).

In this sense, the EU Green Bond Standard was designed to overcome the biggest barriers to the green bond market outlined above. To address legitimacy issues, it builds on the EU Taxonomy to clarify what constitutes as ‘green’ to reduce controversies and reputational risk for issuers. Secondly, to address the heterogeneity, it proposes a standardized verification process which is expected to streamline the process and reduce the cost of external reviews. It also lays the basis for policymakers to design policies and

[5] The environmental objectives of the EU Taxonomy are: (1) climate change mitigation; (2) climate change adaptation; (3) sustainable use and protection of water and marine resources; (4) transition to a circular economy; (5) pollution prevention and control; and (6) protection and restoration of biodiversity and ecosystems.

instruments to incentivize the issuance of green bonds (EU TEG, 2020, pp. 11-12). As such, bond investors should have little doubt that if a green bond is certified under the EU, their use of proceeds are not being greenwashed.

Furthermore, under these conditions, where market pressure can be enhanced through transparency-creating regulation, firms have incentives to signal their superior quality by over-complying with environmental standards (Bernauer & Koubi, 2006). In this case a public standard would be preferred over private standards. Here, a crucial element of the argument rests on the regulatory credibility of the European Union. The EU's environmental regulatory apparatus, anchored in the European Commission and supported by a legalistic institutional culture, has a degree of consistency and legitimacy that few counterparts can match. This gives the EU GBS a particular force in shaping investor expectations. The EU's role is not only material (through legal authority and standard-setting) but also symbolic, reinforcing norms of climate leadership and governance innovation. In this sense, the EU does not simply regulate markets; it defines the frontier of green finance legitimacy. This may not hold for other jurisdictions with less coherent regulatory mandates. Thus, the market reaction to EU regulatory moves is partly a function of this embedded legitimacy: the regulatory impact here is credible not because it is novel, but because it is institutionally expected and politically durable. As such, I theorize that systematic green bond standard issued by a legitimate environmental leader would reduce the heterogeneity of the green bond market and reduce the space for greenwashing.

Finally, given the discussion above on investors being wary of reputational risk over the environmental legitimacy, the introduction of the EU Green Bond Standard could, theoretically, increase the reputational risk associated with holding greenwashed assets. Under the status quo, the risk of public exposure for holding greenwashed bonds was minimal as there was no widely accepted standard for exposing such bonds. The GBS changes this by having a robust standard. While in the long term it would reduce the reputational risk of holding greenwashed assets, in the short term it would increase the perceive risk casting doubt on the legitimacy of bonds certified under private standards. As such, I theorize that a public green bond standard would lead to an increase in yields in the short term.

Heterogeneous effects of public regulation in green bond markets

As I argued in the last section, governing green bonds through market institutions leaves room for greenwashing as the issue of information asymmetry is not entirely resolved. As such, I theorized that a public green bond standard would have a significant impact in the bond market if it came from an actor seen as legitimate. However, to test whether this effect is successful in reducing the space for corporate greenwashing, we should expect that it is not homogeneous across the board. That is, the effect should be more pronounced for firms perceived to be engaging in greenwashing relative to those that are not.

As I mentioned previously, the financial economics literature focusing on green bonds addresses the question of greenwashing mainly by analyzing the effects that third-party verification of individual securities has on their pricing dynamics as effective signaling tools of their environmental credentials (Dinh et al., 2023; Dorfleitner et al., 2022; Ehlers & Packer, 2017; Simeth, 2022). This body of work highlights how internal characteristics of bonds can shape their pricing dynamics. Yet this literature does not tell us much about how the differences across issuers – beyond economic differences – matter. For instance, why an oil and gas company (i.e. Repsol) can exploit the benefits of a green bond premium by having a green bond with external verification. As such, I argue, this strand of research cannot tell us much about the effectiveness of internal bond characteristics in curbing greenwashing.

On the other hand, political economy research indicates that firms perceived as climate laggards, or those heavily reliant on CO2 emissions, are typically the most affected by and opposed to stringent and effective climate action. Meckling (2015), for example, argues that energy-intensive industries in Germany resisted emissions trading because it would substantially raise their compliance costs. Similarly, Kennard (2020) explores why firms from certain industries might support environmental regulations despite the potential increase in their production costs. They suggest that firms with lower adjustment costs may back such regulations to disadvantage competitors facing higher costs, thereby gaining market share and enhancing their competitiveness, particularly in a globalized economy. In line with this, Bechtel et al. (2019) find that individuals working in polluting industries are less supportive of climate cooperation, anticipating higher economic costs.

Beyond initial compliance costs, Genovese and Tvinnereim (2019) argue that sector-level characteristics can moderate firm-level opposition to regulation. They posit that firms with high emissions may initially support regulation because it provides them time to

adapt. However, these firms are also more likely to relocate operations abroad if CO2 prices rise significantly in the long term, increasing their costs. In the context of the U.S. climate change countermovement, Brulle (2021)notes that coal and electrical utility sectors, heavily involved in political coalitions and trade associations, have worked to delay climate policies due to their vested interests in avoiding economic costs associated with regulation. Relatedly, Kim et al. (2016) examine lobbying behaviors, noting that industry leaders often lobby to shape legislation to their advantage, while laggards focus on collective lobbying to block legislation entirely. In contrast, Kelsey (2018) finds that the most effective policy-industry feedback loops occur in jurisdictions with numerous industry leaders and few laggards.

Overall, the literature converges on the notion that the impact of environmental regulation and policy varies based on a firm's position on the leader-laggard spectrum. Therefore, I theorize that the EU green bond standard will have a more pronounced impact on firms with poor environmental reputations.

1.3 Hypotheses

In sum, I argue that, despite being a late comer into a well-established market, the EU Green Bond standard will have a significant impact in green bond pricing dynamics. Given the heterogeneity in the green bond market and the problem of information asymmetry, the arrival of a unified standard from a legitimate actor would translate into higher yields for green bonds as, in the face of a credible new green bond standard, investors would act more conservatively towards green bonds by penalizing environmental controversies, thus impacting corporate greenwashing practices.

However, I do not expect this effect to be homogeneous. Given the theoretical discussion that firms typically classified as climate laggards are those most affected by environmental regulation, I theorize that the EU green bond standard will translate into higher yields for firms with lower environmental scores. Bases on this theoretical discussion, I set out the following main hypotheses.

H1: It will be more expensive to borrow through green bonds after the announcement of EU legislation.

H2: Green bonds issued by environmental ‘laggards will experience higher yields than those issued by environmental ‘leaders.

1.4 Data and empirical approach

To assess the empirical implications of the preceding theoretical discussion I concentrate on the daily yields of green bonds which will be my main outcome variable. Yields are the interest investors can expect from holding the bond until it matures, as such, higher yields mean higher returns for investors and higher borrowing costs for the issuers. Moreover, bond yields and bond prices have an inverse relationship, so as the yield of a bond goes up, its price goes down and vice versa. To this end I extracted all active bonds that traded during the period between February 2022 and May 2023 as well as daily observations from their yield (the mid). Observational data was collected through Refinitiv, the London Stock Exchange Group (LSEG) Data and Analytics service provider.

Moreover, from Refinitiv I also collected several measures on issuers' environmental credentials to test for heterogeneous effects of the EU Green Bond Standard as a proxy for environmental leaders and laggards. First, I collect ESG scores, an overall score based on self-reported information relative to environmental performance and capacity. ESG scores measure the issuer's ESG performance based on public data. I also extract the ESG Controversies score which measures a company's exposure to environmental controversies and negative events reflected in the media. As such, during any given year, if a scandal occurs, the company involved is penalized and this affects their overall Controversies score. The impact of the event may still be seen in the following year if there are new developments related to the negative event, for example, lawsuits, ongoing legislation disputes or fines. It is important to note that both measures account for industry and company size/market capitalization biases as larger companies and issuers from certain industries attract more media attention.

Refinitiv grades issuers based on a letter scale that ranges from A+ to D-. The A score reflects an excellent relative environmental performance and high degree of transparency in reporting environmental data publicly. As such, issuers graded either A+, A, and A- will serve as a proxy for environmental leaders. Conversely, the C and D score ranges indicate, respectively, satisfactory and poor performance and transparency. Thus, I use issuers with these grades as a proxy for environmental laggards.

As a final measure, Refinitiv tracks if the framework under which a green bond is issued is compliant with the EU taxonomy and Green Bond Standard. Here it is important to

note that this measure is not an indicator that a bond is certified under the EU green bond standard, rather it is based on Refinitiv assessment that the core components of the framework in which a green bond is issued comply with the four components of the EU framework, namely, it is aligned with the EU-taxonomy, it publishes a green bond framework, it has mandatory reporting and mandatory verification. As such, bonds that are aligned with this taxonomy will serve as a proxy for environmental leaders, and those that do not comply, as a proxy for laggards.

To estimate the treatment effect of EU regulatory policies on green bond yields, I rely on a regression discontinuity in time (RDiT). A typical regression discontinuity design consists of a running variable or score, a cutoff score, and a discontinuous treatment assignment rule where all units are assigned a value of the running variable and treatment is assigned to those units whose value exceeds the known cutoff score and all others remain untreated such that for a treatment variable X_i observed for each i, if $X_i > c$, the unit is treated, and if $X_i < c$, the subject is not. The main intuition behind this is that units observed near either side of the threshold are very similar so we can assume that nothing else affects the discontinuity in the outcome apart from the treatment. The mild assumptions associated with these designs have made them expand rapidly in the context of policy evaluation and has made these designs one of the most credible non-experimental methods for policy evaluation and causal inference. In contrast to a typical RD design, an RDiT design the cutoff c consists of the date of a policy change instead of a score so that for all dates $t > c$, the units are considered treated and for all other dates $t < c$, the units are not (Cattaneo & Titiunik, 2022; Hausman & Rapson, 2018).

The local average treatment effect (LATE) is estimated using a non-parametric approach that fits observations on a low-order polynomial separately for treated and control groups. This estimation focuses only on observations near the cutoff, rather than using all available data. A triangular kernel function is applied to give more weight to observations closer to the cutoff, and a bandwidth is chosen to define the effective sample size, minimizing the asymptotic mean squared error (MSE).

This non-parametric approach has become the standard choice for RD designs as using parametric approaches we would have to get the functional form of the polynomial right to address any bias introduced by non-linearities between the running variable and the outcome variable. Instead, by using this approach we do not make assumptions about the

underlying data or the functional form of the polynomial; rather, the data drives the shape and produces an estimator with robust bias-corrected standard errors, and *p*-values (Calonico et al., 2014).

In this context I leverage the complexity of the EU's legislative process that has been described as Byzantine and ineffective that systematically generate extremely watered-down deals that hardly change existing European or national provisions (Crombez & Hix, 2015) to use as an as-if random treatment. A potential concern in such designs is the presence of anticipation effects, whereby political events are priced in before they occur. However, as Bechtel and Schneider (2014) argue, such concerns are mitigated in the context of EU policymaking. Specifically, they note that the precise agenda of European Council meetings is frequently unknown beforehand, making it difficult for investors to predict the timing and content of policy announcements. Furthermore, the EU's "stop-and-go" pattern of integration complicates expectations, even if the agenda were known. This combination of institutional opacity and policy unpredictability supports the assumption that market participants cannot systematically anticipate outcomes, thus reinforcing the plausibility of my identification strategy.

The European Council and European parliament reached a political agreement on the EU Green bond Standard on the 28th of February 2023; however, this agreement was announced the following day on the 1st of March. As such, I will use that date as the cutoff date (c). I estimate the LATE using a local linear regression to avoid the inference problems that characterize higher-order polynomials such as overfitting the data, producing noisy estimates, and poor coverage of confidence intervals, as well as the fact that higher-order polynomials are harder to justify and interpret theoretically (Cattaneo & Titiunik, 2022; Gelman & Imbens, 2019). To test the main hypothesis H1 I rely on the following model:

$$GBYield_{i,t} = \beta_0 + \beta_1 f(t - T_i) + \beta_2 \chi_{i,t} + \gamma_i + \eta_t + \varepsilon_{i,t} \quad (1)$$

Where $GBYield_{i,t}$ is the yield of green bond i on day t, T_i is the day that the legislation approving the EU Green bond standard was announced (01-03-2023), $t - T_i$ is the time interval from the outcome variable to the cutoff or reference point and β_1 is the coefficient

of interests that captures the effect of EU legislation and $f(t - T_i)$ is the local polynomial specification that, in the main analysis takes the linear form $\beta_1(t - T_i)$. However, I also provide alternative estimations with polynomials $p = 1, 2, 3, 4$ to test the robustness of the main estimate. Following Calonico et al. (2014), I specify a mean optimal bandwidth of 33 days around the cutoff date and also provide alternative specifications with different bandwidths to test the robustness of the main estimate. $\chi_{i,t}$ is a vector of time-varying bond characteristics that serve as controls such as liquidity defined as the Bid-Ask spread. Finally, γ_i and η_t represent issuer and daily fixed effects to account for any unobserved heterogeneity, and $\varepsilon_{i,t}$ is the stochastic error term clustered at the individual bond level.

In line with Hausman and Rapson (2018), I conducted several diagnostic and identification tests to identify and support the validity of this model such as plotting the raw data helps identify signs of time-varying treatment effects, conducting a parallel RD estimate on a control variable to demonstrate continuity and conducted several robustness checks and placebo tests that appear in the appendix.

Furthermore, to test for the heterogeneous effects specified by H2 which refer to verification and environmental reputation status respectively, I follow an analogous model to (1) but split in subgroups so that the main estimate is conditional on whether a bond is verified or not and whether it is an environmental leader or laggard based on the definitions discussed above.

1.5 Results

In this section I present the results of the empirical approach outlined in the previous section. First, in Figure 1.1, we see a regression discontinuity plot (RD Plot) of the full data set that illustrates the relationship between bond yields and days relative to the approval of EU Green Bond Standard. The individual data points plotted in gray, representing the daily means of green bond yields. The blue line, which represents a polynomial function fit to the data, is fitted separately on either side of the vertical dashed line marking the cut-point. As can be clearly seen in the plot, green bond yields show a substantive increase after the announcement of the Green Bond Standard with a visible discontinuity in the cutoff point. However, the visual evidence alone does not confirm whether this discontinuity is statistically significant, nor does it account for any underlying factors that might differ across the cut-point. While RD plots are useful to

provide a visual guide of the research design, it should not be used as a substitute for the formal estimation of discontinuity effects (Cattaneo & Titiunik, 2022).

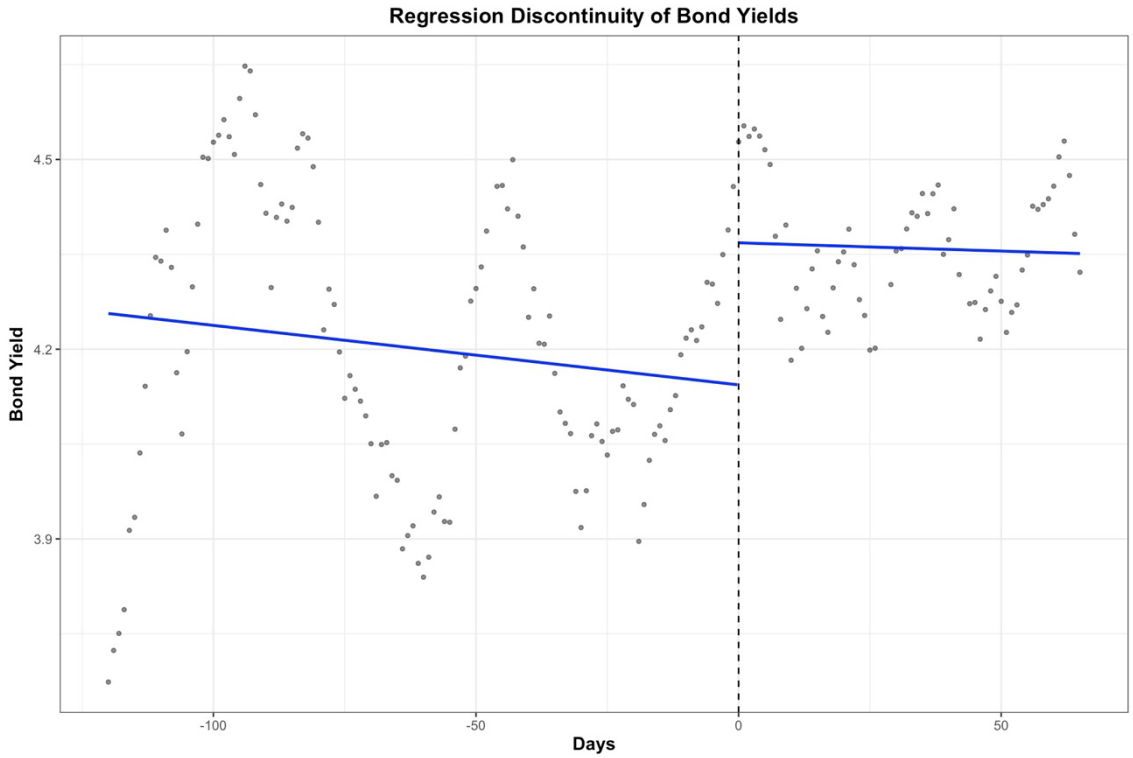

Figure 1.1: RD Plot of Green Bond Yields by Issuer

The formal RDiT estimates are done following the nonparametric approach of CCT mentioned previously and appear in Figure 1.2. This figure shows the point estimates and 95% confidence intervals of the local average treatment effect that euro-denominated green bonds exhibited after the EU Green Bond Standard was announced. Following CCT I present three estimates: a traditional linear estimation without adjusting for potential bias in the polynomial specification as mentioned above, a bias-corrected point estimate that accounts for the asymptotic bias introduced by the curvature of the regression function, and an additional bias-corrected point with robust standard errors.

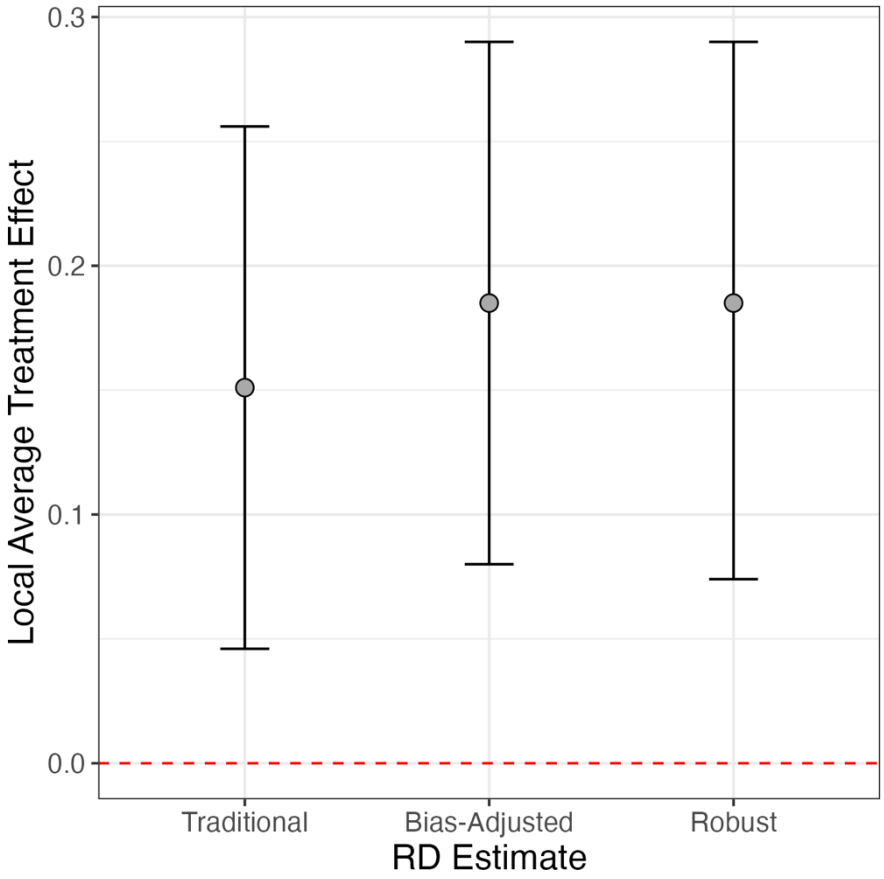

Figure 1.2 Local Average Treatment Effect

Figure 1.2 illustrates a substantive and statistically significant increase in green bond yields following the EU legislation. The figure also shows that a traditional estimate, without bias- correction, is more conservative, indicating only a 15 basis points (bps) increase. In contrast, both the bias-corrected and robust estimates suggest an increase closer to 19 bps. To put this effect in context, Central Banks typically adjust interest rates in 25 bps increments when attempting to slow down the economy so we can think of the announcement of EU Green Bond Standard as having a comparable slowing-down effect in green bonds. In the previous section I theorized that this increase is due to the fact that bond investors are wary of greenwashing and, as such, a new credible standard that reduces information asymmetry in the market would make the bond investors act more conservatively. This slow-down of the green bond market after the EU announcement shows robust initial support for H1. The RDiT estimates for the plot appear in Table 1.1.

Table 1.1 Formal RD Estimates

Outcome	Sample	Method	RD Estimate	SE	P-Value
Bond Yields	Full	Conventional	0.151	0.054	0.005
		Bias-Corrected	0.185	0.054	0.001
		Robust	0.185	0.057	0.001

Note: RdiT estimates, standard errors, and p-values of the Local Average Treatment Effect on Daily Returns. Estimates with 1st order polynomials, triangular kernel and Mean Squared Error optimal bandwidth. Using issuer, industry, country and daily fixed effects and controlling for liquidity (Bid-Ask spread) with cluster-robust standard errors at the ISIN level.

Secondly, I turn to how differences across issuers matter by at issuers that can be thought of as environmental leaders and those that can be classified as environmental laggards. Figure 1.3 plots the three different proxies discussed above for environmental leaders and laggards, namely environmental controversies, ESG scores, and those that are aligned with the the EU taxonomy in the assessment of Refinitiv (not that the bond is actually certified under the EU green bond standard). For brevity I present only the robust estimators of the three analyses, but the complete estimators are available in the Supplementary Material. The first panel divides shows the coefficients and confidence intervals of the environmental leaders for each of the proxies. Conversely, the second panel shows the environmental laggards.

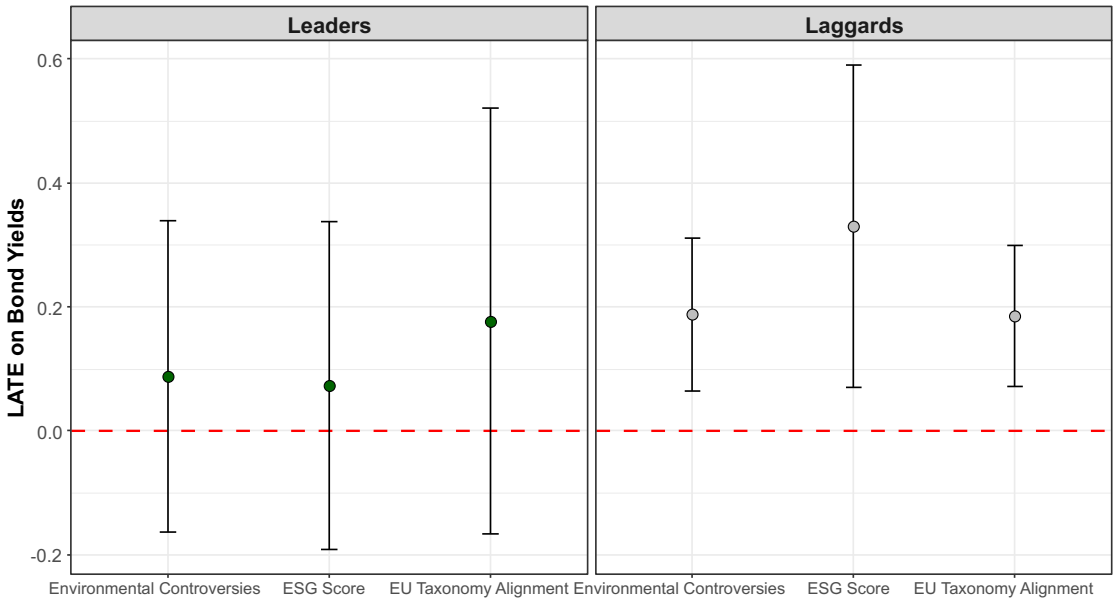

Figure 1.3 LATE on Bond Yields for Leaders and Laggards

Figure 1.3 and the respective estimates in Table 1.2 show marked heterogeneity and provide suggestive evidence that environmental reputation serves as a potential mechanism behind the local treatment effect observed after the announcement of the green bond standard in bond yields. Moreover, the point estimates are larger for bonds issued by environmental laggards, but their confidence intervals are smaller and are the only ones that are statistically significant. Together, I take these estimates to provide strong support for H2 given that the increase of yields was more pronounced on issuers that are seen as environmental laggards.

Table 1.2 RD Estimates for Environmental Leaders and Laggards

Outcome	Sample		RD Estimate	SE	P-Value
Bond Yields	Controversies Leaders	Conventional	0.189	0.121	0.118
		Bias-Corrected	0.088	0.121	0.465
		Robust	0.088	0.128	0.489
	Controversies Laggards	Conventional	0.137	0.061	0.026
		Bias-Corrected	0.188	0.061	0.002
		Robust	0.188	0.063	0.003
	ESG Leaders	Conventional	0.161	0.128	0.208
		Bias-Corrected	0.073	0.128	0.57
		Robust	0.073	0.135	0.589
	ESG Laggards	Conventional	0.303	0.119	0.011
		Bias-Corrected	0.33	0.119	0.006
		Robust	0.33	0.133	0.013
	EU Aligned	Conventional	0.22	0.162	0.174
		Bias-Corrected	0.177	0.162	0.273
		Robust	0.177	0.175	0.311
	EU Aligned	Conventional	0.143	0.057	0.011
		Bias-Corrected	0.185	0.057	0.001
		Robust	0.185	0.058	0.002

Note: RdiT estimates, standard errors, and p-values of the Local Average Treatment Effect on Daily Returns. Estimates with 1st order polynomials, triangular kernel and Mean Squared Error optimal bandwidth. Using issuer, industry, country and daily fixed effects and controlling for liquidity (Bid-Ask spread) with cluster-robust standard errors at the ISIN level.

In the previous section, I suggested that if it were the case that the credibility of the EU Green Bond Standard would have an impact due on the asymmetry in the green bond market, the effect shown in the previous estimate would not be homogeneous but would differ depending on the environmental credibility of the bonds.

In contrast to an issuer's environmental reputation, Figure 1.4 shows the regression discontinuity estimates of the subgroup of bonds with a second-party opinion and those without one and the formal estimates are shown in Table 1.3. While there are some slight differences that suggest that uncertified green bonds had a larger increase in their yields vis-à-vis certified ones, these differences appear to be neither substantively nor statistically significant. As such, the empirical evidence suggests that – in the face of a new standard – bond investors do not see any difference between bonds with external verification and those without. These results and the theory outlined above suggest that the heterogeneity in the verification market is not enough to effectively reduce the information asymmetry of green bonds. Again, controversial cases such as airports or fossil fuel companies receiving external verification support the theory.

Table 1.3 RD Estimates for Environmental Leaders and Laggards

Outcome	Sample		RD Estimate	SE	P-Value
Bond Yields	Certified	Conventional	0.15	0.08	0.05
		Bias-Corrected	0.2	0.08	0.01
		Robust	0.2	0.08	0.01
	Not Certified	Conventional	0.15	0.07	0.03
		Bias-Corrected	0.21	0.07	0.00
		Robust	0.21	0.07	0.00

Note: RdiT estimates, standard errors, and p-values of the Local Average Treatment Effect on Daily Returns. Estimates with 1st order polynomials, triangular kernel and Mean Squared Error optimal bandwidth. Using issuer, industry, country and daily fixed effects and controlling for liquidity (Bid-Ask spread) with cluster-robust standard errors at the ISIN level.

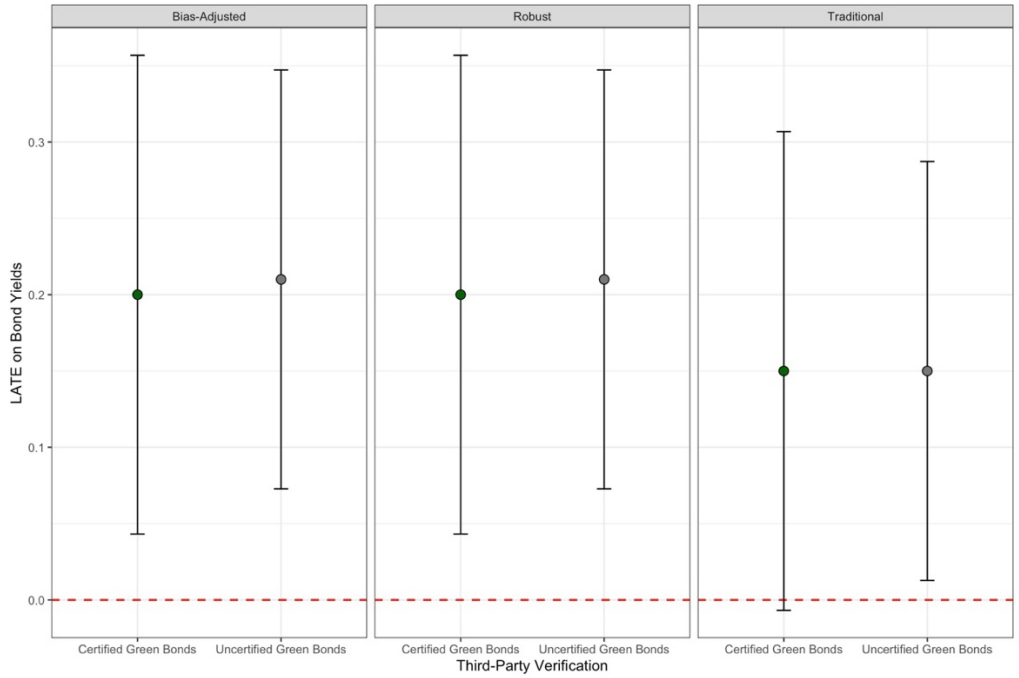

Figure 1.4 LATE SPO vs Non-SPO

Robustness Checks. To increase our confidence in these results I conducted a series of additional robustness tests and found that they are highly robust to other methodological approaches. A full discussion of these tests, appears in the Supplementary Appendix, however, it should be noted that these robustness checks indicate that the cutoff point is meaningful through a series of regressions with placebo cutoff points 5 trading days before and after the specified cut-point (Figure A.1.2) and the results presented here do not depend significantly on the specified polynomial specification as the results are robust for polynomials p = 1, 2, 3, 4 (Figure A.1.3) and different bandwidths (Figure A.1.4). Also, given that my paper's logic rests on the idea that public standards have a greater effect on pricing that private ones, I conducted a supplementary analysis testing the announcement of the Climate Bonds Initiative Standard and find no significant effect (Table A.1.4). In order to test for alternative mechanisms such as supply-side

explanations I also tested the effect of the EU Green Bond Standard on primary markets issuances and find no effect as well (Table A.1.2 and Table A.1.3). Most importantly, I test the design using a series of placebo outcomes such as Euro-denominated conventional bonds and Dollar-denominated green bonds and find that the announcement of the EU Green Bond standard had no discernible effect on their yields (Figure A.1.1). Finally, I analyzed the main effect using an alternative *difference-in-differences* estimator between a sample of green bonds matched to similar conventional bonds (Imai et al., 2023) and find qualitatively similar results (Figure A.1.7). This lack of effect of the EU legislation on bonds other than Euro Green bonds, when combined with the results from the main RDiT estimates, suggests a causal effect where regulation leads to a more conservative approach from investors towards green bonds. Crucially, this effect seems to be concentrated on issuers with poor environmental reputation. As such, overall, these results and the theory outlined above imply that EU regulation was effective in squeezing greenwashing in the green bond market in the short term due to the heterogeneity and information asymmetry that currently exists in market-based mechanisms to define what counts as 'green'.

1.6 Discussion

The results presented here paint a clear picture of the immediate effects that the introduction of the EU Green Bond Standard has had on the green bond market. In the short term, as demonstrated by the regression discontinuity analyses, the regulation has prompted a noticeable shift in investor behavior, particularly through a conservative repricing of green bonds, especially among issuers with questionable environmental reputations. This shift, while anticipated, underscores the importance of credibility in environmental claims within the financial sector and provides crucial insights into the impact of state regulation on market dynamics.

These short-term effects suggest that investors are quickly responsive to formal regulations and place increased importance on issuers' environmental credibility when such regulations are implemented. This immediate reaction might indicate that future regulatory efforts could benefit from focusing on enhancing market transparency and standardization to ad- dress information asymmetry and discourage greenwashing practices. However, as my theory suggests, this was mainly the function of the current market-based regulation and mechanisms to address the issue of information asymmetry

given the heterogeneous and diverse criteria for defining what counts as green. The mixed early evidence regarding external verification, as illustrated in Figure 3, further underscores the complexities of initial market responses and the potential limitations of existing certification mechanisms. As such, the credibility and legitimacy that the European Union has as a climate leader were crucial to this effect: if investors did not consider the EU Green Bond standard to add any value we would not have observed such a stark market reaction to its announcement, just as it is plausible we would not observe any effect if the EU proposed a credit rating standard to compete with those of the Big Three credit rating agencies.

However, beyond these immediate effects, the results also raise important questions regarding the long-term impact of such regulations. Specifically, whether this initial market reaction will lead to sustained changes in how green bonds are valued and whether it will drive broader improvements in environmental performance among issuers. In this regard, in the short term, the EU Green Bond Standard leads to an increase in bond yields for green bonds, resulting in a reduction in greenium across the board as the market adjusts to new, more stringent requirements. However, this initial market reaction could pave the way for a more nuanced and potentially more pronounced greenium in the long run. As investors become more discerning and the market matures under the new regulatory framework, a clearer differentiation between truly green issuers and environmental laggards may emerge. Over time, this could result in a two-tiered market where bonds issued by companies with strong environmental credentials and full compliance with the EU standard command a higher greenium, while those from laggards see their greenium erode or disappear. This divergence could create a powerful financial incentive for laggards to improve their environmental performance. While the introduction of the EU Green Bond Standard may have a negative effect in the short term for bond issuers, it also has the potential to generate long-term positive effects on the green bond market, particularly through mechanisms akin to the "California effect" and the Porter Hypothesis. Both theories provide valuable insights into how stringent environmental regulations can not only prompt immediate changes but also drive more substantial shifts in market behavior and firm practices over time, encouraging environmental laggards to improve their practices to take advantage of the premiums associated with green bonds. This is especially true in the EU given its track history of

influencing climate outcomes through convergence and policy diffusion (Bayer & Aklin, 2020; Gawel & Strunz, 2019).

The "California effect," originally conceptualized by David Vogel (1995), describes how firms are often willing to adopt stricter regulations if such compliance is necessary to access profitable markets. This effect has been observed in various contexts, including environmental and labor standards, where firms operating in less-regulated environments adopt higher standards to compete in markets with more stringent requirements (Distelhorst & Locke, 2018; Malesky & Mosley, 2018; Prakash & Potoski, 2006). In the context of green bonds, as the market grows and potentially offers more favorable terms for compliant issuers, it could create a competitive incentive for environmental laggards to improve their practices in order to gain the economic benefits associated with the green bond premium. Thus, "environmental laggards"—those with poorer environmental reputations—might begin to upgrade their practices to align with the stringent requirements of green bond investors. Initially, the introduction of the EU regulation leads to a reduction in the greenium as issuers adjust to the new, stricter standards. This short-term adjustment reflects investor caution as they reassess the credibility of green bond issuers under the new regulatory framework. However, this period of adjustment could eventually lead to a bifurcation in the green bond market, where greener issuers—those with strong environmental credentials—benefit from a higher greenium compared to bonds issued by laggards. As investors increasingly differentiate between issuers based on their environmental performance, the greenium for bonds from credible, environmentally responsible firms is likely to rise, while bonds from laggards may face higher yields due to perceived risks of greenwashing.

Moreover, the Porter Hypothesis offers another perspective on the potential long-term benefits of the EU Green Bond Standard. The hypothesis suggests that well-designed environ- mental regulations can stimulate innovation and improve the competitiveness of firms. While traditional economic theory suggests that environmental regulations may impose costs that reduce productivity, the Porter Hypothesis argues that these regulations can actually spur firms to innovate in ways that offset or even exceed the costs of compliance. For example, investment in pollution control technologies, while initially costly, can lead to long-term efficiency gains and open up new markets for environmentally friendly products. In the case of green bonds, the EU Green Bond Standard could encourage firms to invest in cleaner technologies and sustainable practices

as a means of complying with the standard and benefiting from the greenium. Over time, as firms develop and adopt new technologies and practices to meet these standards, they may experience productivity gains and increased competitiveness, both in the green bond market and in their broader operations. This aligns with evidence from previous studies that find the immediate negative effects of regulations on productivity are temporary and that in the long run, regulation leads to higher levels of productivity compared to firms in less regulated areas (Berman & Bui, 2001; Lanoie et al., 2008).

The potential for a "California effect" or Porter Hypothesis dynamic in the green bond market suggests that the EU Green Bond Standard could have far-reaching implications beyond its immediate impact. By raising the bar for what qualifies as a green bond, the EU regulation could drive a global "trading up" of environmental standards, particularly among firms looking to tap into the growing demand for sustainable investments. This could lead to a broader transformation of corporate environmental practices, particularly among firms that were previously less committed to sustainability.

Thus, while the short-term effect of the EU Green Bond Standard may initially reduce the greenium as issuers adjust to stricter regulations, this adjustment period could ultimately lead to higher greenium levels for bonds issued by environmentally credible firms compared to those from laggards. This differentiation in the market would enhance the credibility and effectiveness of the green bond market and contribute to a more sustainable global economy in the long term, as the benefits of compliance and innovation gradually outweigh the initial costs imposed by the regulation.

1.7 Conclusions

The analysis presented in this paper demonstrates that the introduction of the EU Green Bond Standard (EU GBS) has had a discernible impact on the green bond market, particularly in the pricing dynamics of these financial instruments. The empirical evidence suggests that the announcement of the EU GBS led to a significant increase in green bond yields, reflecting a shift in investor behavior towards greater caution and scrutiny. This finding sup- ports the hypothesis that the introduction of a credible and stringent regulatory standard can influence market perceptions and drive a more conservative pricing approach, particularly in markets characterized by high levels of information asymmetry, as seen in the green bond market.

One of the key insights from this study is the role of environmental reputation in mediating the impact of the EU GBS. Bonds issued by companies classified as environmental laggards experienced a more pronounced increase in yields compared to those issued by environmental leaders. This suggests that the EU GBS has the potential to exert pressure on issuers with weaker environmental credentials, incentivizing them to improve their practices to remain competitive in the green bond market. However, the mixed results regarding the effect of external verification highlight the complexity of market dynamics and suggest that not all market-based mechanisms are equally effective in reducing information asymmetry.

The findings of this paper have important implications for policymakers, investors, and issuers. For policymakers, the results underscore the effectiveness of regulatory interventions like the EU GBS in enhancing market integrity and reducing greenwashing. By setting clear and stringent standards, regulators can help ensure that green bonds truly contribute to environmental sustainability, thereby strengthening investor confidence and supporting the growth of sustainable finance. For investors, the results highlight the importance of due diligence and the need to critically assess the environmental credentials of green bonds, even when they are externally verified. Finally, for issuers, the findings suggest that aligning with credible standards such as the EU GBS can mitigate the risk of higher yields and help maintain access to the growing pool of capital dedicated to sustainable finance.

In summary, the EU Green Bond Standard appears to be a meaningful intervention in reducing information asymmetry and incentivizing more credible green bond issuance. While the initial impact is reflected in yield increases, this regulatory shift could promote more sustainable practices over time. The findings affirm the EU's influential role in shaping market governance through credible, enforceable public standards.

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Appendix 1.A Placebo Outcomes

In order to increase our confidence that the observed changes in bond yields are truly attributable to the Green Bond Standard, rather than other extraneous factors, I test the effect of the treatment on several placebo outcomes. This strategy helps control for confounding factors and also aids in ruling out placebo effects, thereby distinguishing between genuine treatment effects and random effects. Furthermore, assessing placebo outcomes enhances the internal validity of the study by providing evidence against alternative explanations for the observed results. It can also reveal the specificity of the intervention's effects, clarifying whether it has a targeted impact on the intended outcome or a broader, non-specific influence.

As such, I test the effect of the approval of the EU Green Bond Standard on the yields of Euro-Denominated Conventional Bonds and Dollar-Denominated Green Bonds, with the expectation that these samples should not experience any significant effects. Additionally, I also test the effect on liquidity, given its role as our main time-variant covariate.

As can be seen in both Figure A.1 and Table A.1, none of the placebo outcomes show substantive or statistically significant effects after the EU's announcement.

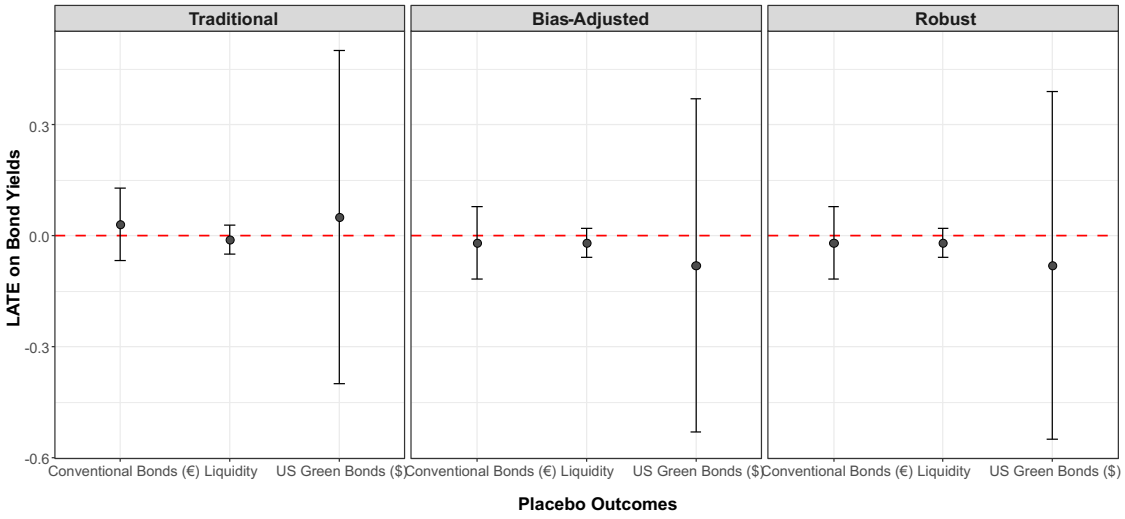

Figure A.1.1 LATE on Placebo Outcomes

Table A 1.1 RD Estimates Using Placebo Outcomes

Outcome	Estimate	RD Estimate	SE	P-Value
Green Bonds ($)	Conventional	0.05	0.23	0.83
	Bias-Corrected	-0.08	0.23	0.73
	Robust	-0.08	0.24	0.73
Conventional bonds (€)	Conventional	0.03	0.05	0.5
	Bias-Corrected	-0.02	0.05	0.62
	Robust	-0.02	0.05	0.61
Liquidity (€ Green Bonds)	Conventional	-0.01	0.02	0.79
	Bias-Corrected	-0.02	0.02	0.38
	Robust	-0.02	0.02	0.41

Note: RdiT estimates, standard errors, and p-values of the Local Average Treatment Effect on bond yields for dollar denominated green bonds issued in the US and for conventional bonds issued in the EU. Estimates with 1st order polynomials, triangular kernel and Mean Squared Error optimal bandwidth using cluster-robust standard errors at the ISIN level.

Effect on Primary Market Supply

Given my focus on secondary market analysis, supply-side considerations that could influence primary market issuance in the immediate lead-up to the launch of the EU Green Bond Standard (EU GBS), such as the possibility that environmentally weaker firms might withdraw from the market if they anticipate any impact from the EU GBS, are likely to have limited real-world implications. Furthermore, since I theoretically argue that yields would increase immediately following the introduction of the EU GBS, if environmentally lagging firms were to refrain from issuing green bonds, we would, in theory, expect to observe the opposite effect of what is reported.

Nonetheless, to address the potential concern that a discontinuity in yields might result from weak issuers choosing not to issue bonds due to expectations surrounding the EU GBS, I examine the effect of the Standard on primary market issuance. Specifically, I test whether there is a significant difference in the average size of bonds issued on either side of the EU GBS threshold. I first apply a Regression Discontinuity in Time (RDiT) approach, similar to that used in the main analysis using the issue size of green bonds (logged) issued either side of the cutoff date

I then compare the average bond issuance between the two-month periods before (January– February 2023) and after (March–April 2024) the announcement of the Standard using a two-sample t-test.

As shown in Tables A.1.2 and A.1.3, the EU GBS has no discernible effect on primary market outcomes.

Table A 1.2 RD Estimates of GBS on Issue Size

Outcome	Estimate	RD Estimate	SE	P-Value
Issue Amount (log)	Conventional	-0.004	0.063	0.951
	Bias-Corrected	-0.001	0.063	0.987
	Robust	-0.001	0.064	0.988

Note: RdiT estimates, standard errors, and p-values of the Local Average Treatment Effect on bond yields for dollar denominated green bonds issued in the US and for conventional bonds issued in the EU. Estimates with 1st order polynomials, triangular kernel and Mean Squared Error optimal bandwidth using cluster-robust standard errors at the ISIN level.

Additionally, I conduct an independent sample t-test to determine whether the difference in means between the average bond issuance between the two-month periods before (January– February 2023) and after (March–April 2024) is statistically significant and I

fail to reject the null hypothesis ($p > 0.05$). The descriptive statistics of the sample appear in Table A.3

Table A 1.3 Summary Statistics for Both Periods

Period	Mean	Standard Deviation (SD)	Sample Size (N)
January-February	528,431,016.7	858,501,009.5	180
March-April	539,623,167.8	1,604,427,811	94

Effects of Private Regulatory Standards

To support my main hypothesis—that public standards have a much larger effect on bond pricing than private-sector ones, I present an alternative analysis testing the impact of a private standard on bond yields. Currently, there are two main private standards: the International Capital Market Association's (ICMA) Green Bond Principles and the Climate Bonds Initiative's (CBI) Climate Bonds Standard and Certification Scheme. ICMA's Green Bond Principles came into effect in April 2014, while CBI's Standard was introduced in December 2019. Due to the limited development of the green bond market in 2014, data availability makes it infeasible to analyze the effect of the Green Bond Principles on bond pricing.

As such, I estimate the effect of the CBI Standard using equation (1) from the main text, applied to a sample of all euro-denominated green bonds traded in the European Union between December 11, 2018, and March 11, 2020, using the announcement date (December 11, 2019) as the cutoff point. As shown by the results, the effect is not only statistically insignificant but also considerably smaller than the effects observed following the introduction of the EU GBS.

Table A 1.4 RD Estimates of CBI Standard

Outcome	Estimate	RD Estimate	SE	P-Value
Bond Yields	Conventional	0.009	0.219	0.966
	Bias-Corrected	0.008	0.219	0.972
	Robust	0.008	0.191	0.967

Note: RdiT estimates, standard errors, and p-values of the Local Average Treatment Effect on bond yields for dollar denominated green bonds issued in the US and for conventional bonds issued in the EU. Estimates with 1st order polynomials, triangular kernel and Mean Squared Error optimal bandwidth using cluster-robust standard errors at the ISIN level.

Appendix 1.B Robustness Tests

Placebo Cut points

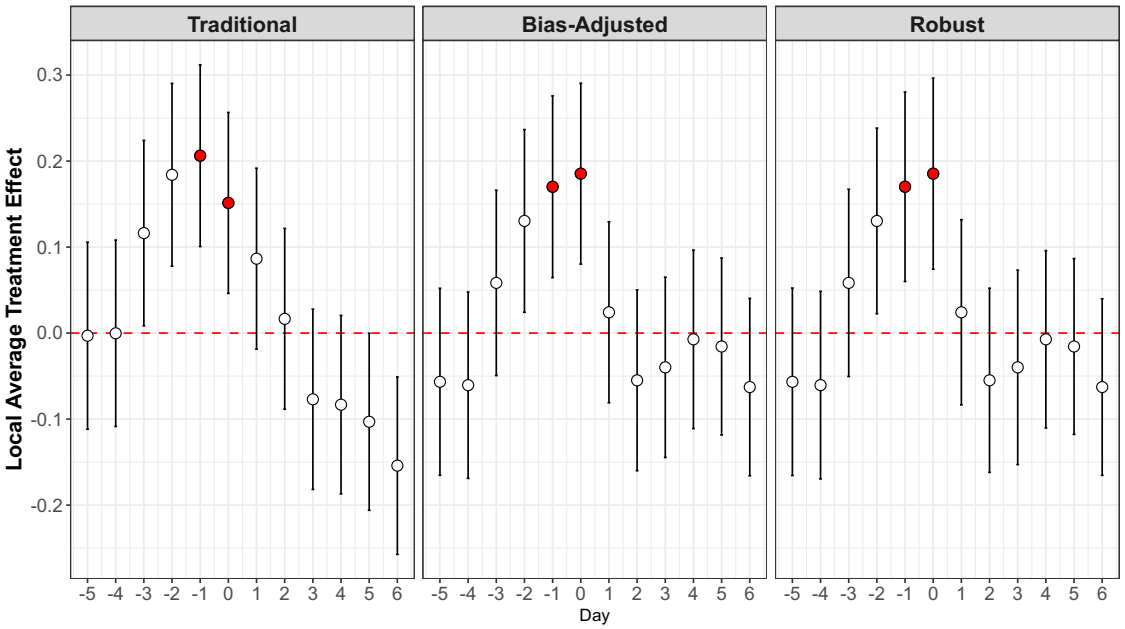

Figure A.1.2 LATE Using different cut points. Red dots represent the selected potential cutoff points (the 28th of February and the 1st of March, 2023)

Alternative Polynomial Specifications

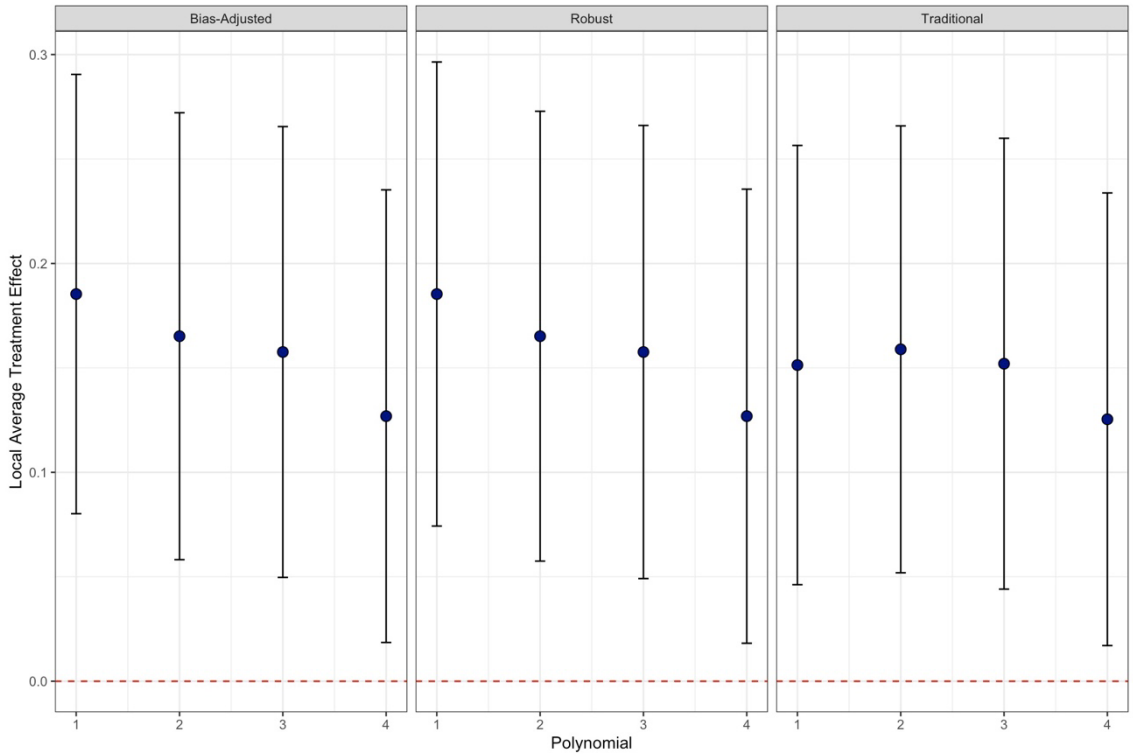

Figure A.1.3 LATE Using different polynomials

Table A 1.5 RD Estimates with different polynomials

Outcome	Polynomial	Method	RD Estimate	SE	P-Value
Bond Yields	1	Conventional	0.151	0.054	0.005
		Bias-Corrected	0.185	0.054	0.001
		Robust	0.185	0.057	0.001
	2	Conventional	0.159	0.055	0.004
		Bias-Corrected	0.165	0.055	0.002
		Robust	0.165	0.055	0.003
	3	Conventional	0.152	0.055	0.006
		Bias-Corrected	0.158	0.055	0.004
		Robust	0.158	0.055	0.004
	4	Conventional	0.125	0.055	0.023
		Bias-Corrected	0.127	0.055	0.022
		Robust	0.127	0.055	0.022

Note*: RdiT estimates, standard errors, and p-values of the Local Average Treatment Effect on Daily Returns. Estimates with 1st order polynomials, triangular kernel and Mean Squared Error optimal bandwidth. Using issuer, industry, country and daily fixed effects and controlling for liquidity (Bid-Ask spread) with cluster-robust standard errors at the ISIN level.*

LATE under different Bandwidths

In the main text we estimate the discontinuity within a narrow bandwidth of 33 days in the pre-period and 33 days in the post-period as it is the optimal bandwidth as per CCT's nonparametric approach (Calonico, Cattaneo, and Titiunik 2014). Here we present alternative specifications using varying bandwidths ranging from [-10, 10] days in the pre and post-period to [-40, 40] days as is common in RDiT designs (Hausman and Rapson, 2018).

However, we need to acknowledge that a challenge in bandwidth selection in RDiT designs arises from the fundamental differences between time-based and cross-sectional designs. Given that RDiT relies on variation in the time dimension we cannot grow the sample size while simultaneously shrinking the bandwidth (the proximity to the threshold) as such reducing the bandwidth too much may introduce additional bias due to the time-series properties of the data generating process and reduced number of observations (Hausman and Rapson, 2018).

Figure A.1.4 shows that the local average treatment effect varies with different bandwidths. We can see that we find both substantive and statistically significant effects of the EU GBS similar to those reported in the main analysis.

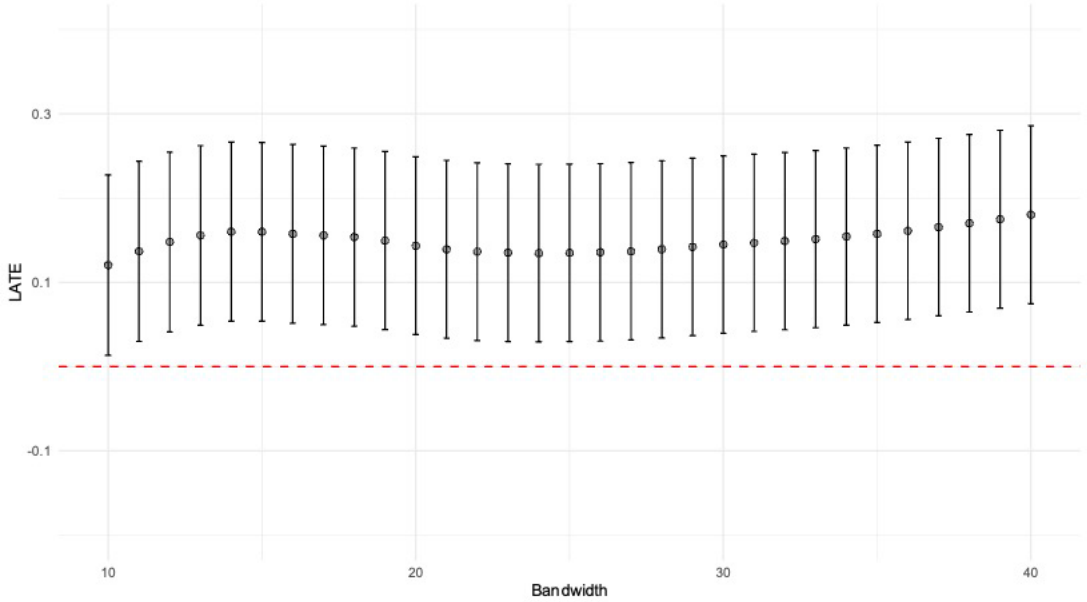

Figure A.1.4 LATE under different bandwidths

Appendix 1.C Full Figures of Leaders and Laggards Estimates Environmental Controversies

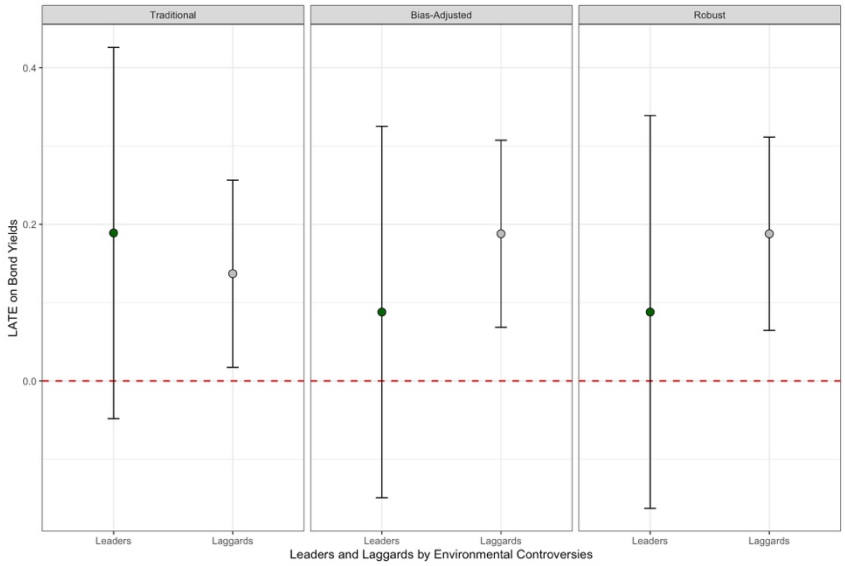

Figure A.1.5 Leaders and Laggards Environmental Controversies

ESG Scores

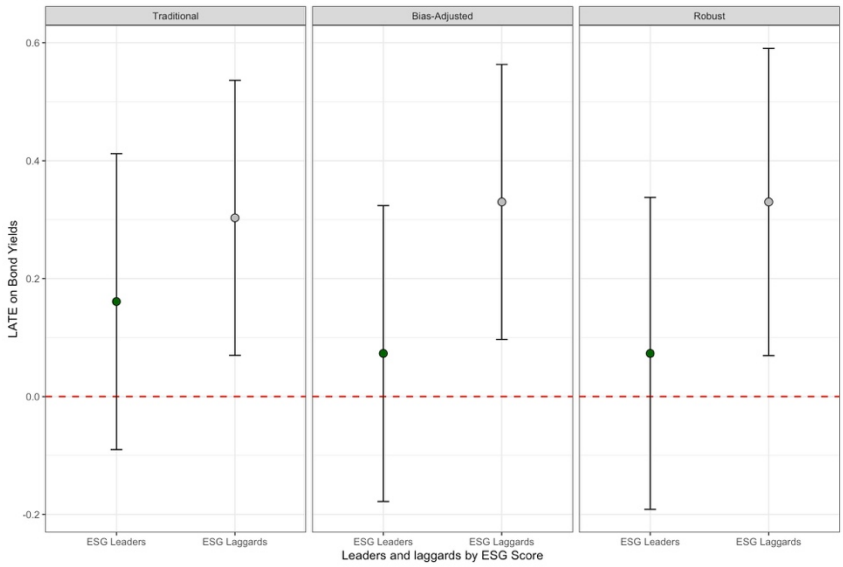

Figure A.1.6 Leaders and Laggards ESG Scores

EU Taxonomy Alignment

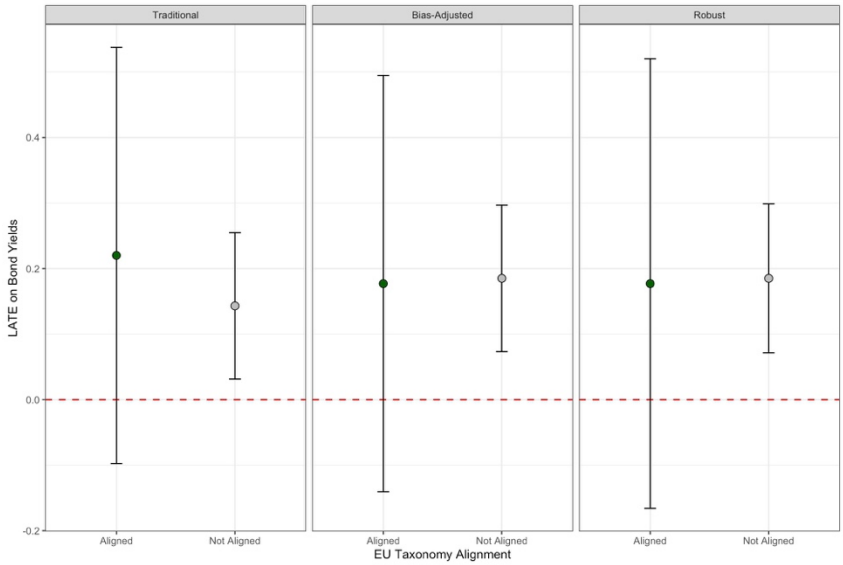

Figure A.1.7 Leaders and Laggards Taxonomy Alignment

Appendix 1.D Difference-in-Differences Specification

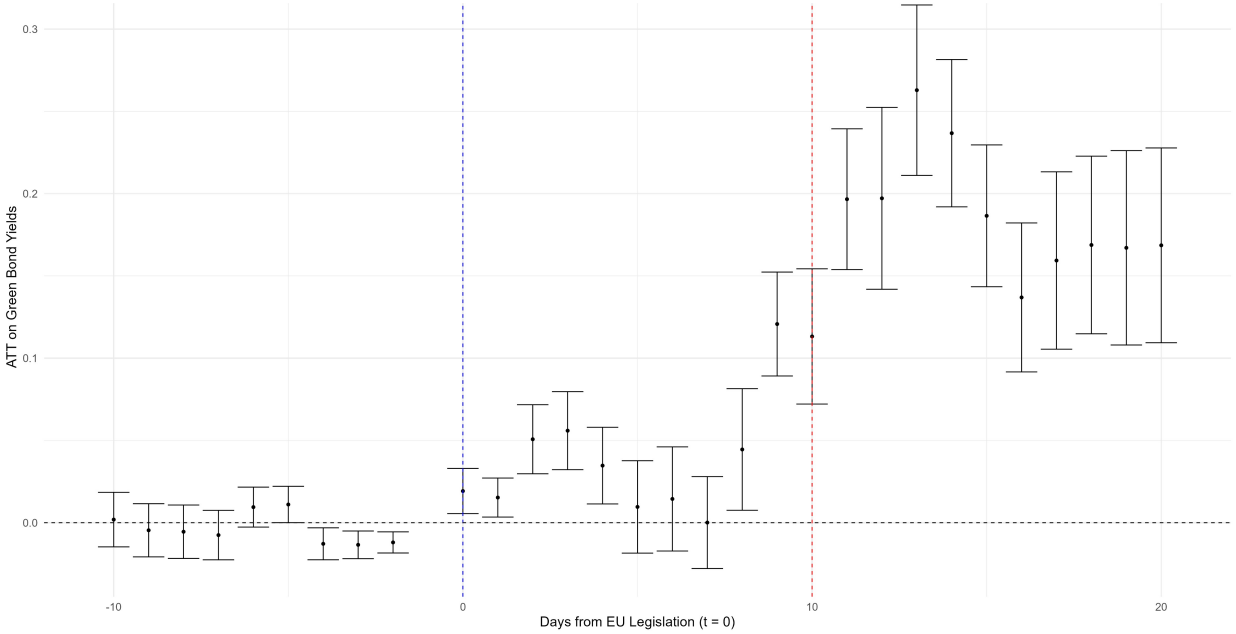

Figure A.1.8 Event Study Plot

Paper 2

2 Banking against sustainable Finance The effect of the European Central Bank operations on Green Bond prices.

Abstract

This paper highlights the unintended consequences of central bank practices on climate finance performance. By providing information on central banks' willingness to buy individual bonds from investors, collateral frameworks can reassure or spook market actors. While central bank collateral frameworks have been subjected to some analysis, their relationship with sustainable finance has been overlooked. By comparing matched green and conventional bonds, this paper finds robust empirical evidence of an anti-green bias at the European Central Bank, whose collateral framework systematically under-values green bonds relative to conventional bonds. It also shows that the ECB collateral framework moves markets; the lower value that the ECB imposes on green bonds translates into higher borrowing costs for green bond issuers, constraining the financing available to support the economic activities needed for a green transition. Given the ECB commitment to ensure that all of its policies are aligned with the objectives of the Paris Agreement, it is important that its impact on green bonds and potentially other forms of sustainable finance be subjected to further review and analysis.

2.1 Introduction

Climate change is one of the defining issues of our time, and we are at a crucial moment. The gravity of this issue led to the adoption of the Paris Agreement and underpins several of the Sustainable Development Goals agreed in 2015. Ever since, expanding the financing available to fund sustainable transitions has become a global priority (Agliardi & Agliardi, 2019, p. 608). It has been estimated that the world needs an annual investment of around 2.2 per cent of global GDP to deliver the commitments from the SDGs and the Paris Agreement. Nonetheless, current levels of investment fall well short of this figure (GFANZ, 2023). In this sense, finding ways to unlock new and additional finance for climate-related projects is crucial. Private capital and market-based financing are seen as vital components of climate financing. In this regard, the development of green bonds has been called one of 'the most important financial breakthroughs in the domain of sustainable finance during the last 15 years' (Agliardi & Agliardi, 2019; Ando et al., 2022). This innovative asset class is considered a principal mechanism through which to raise private capital to finance the fight against climate change (Bachelet et al., 2019; Langley et al., 2021).

Green bonds can unlock additional climate finance by trading at a premium, often called a 'greenium,' which allows issuers to borrow at lower costs compared to similar conventional bonds. In this paper, I explore whether central bank behavior constrains or promotes this premium at which green bonds trade. Specifically, I assess the impact of the European Central Bank Collateral Framework on green bond performance. Through its Collateral Framework, the ECB assesses the 'riskiness' of bonds and, as such, signals to market participants looking to use bonds as collateral for Central Bank credit the discount or haircut against prevailing market value they will apply when purchasing a bond. By using a matching method to identify essentially identical pairs of bonds, I find that as the ECB increases the discount it applies to green bonds, it results in less favorable borrowing conditions for issuers of green bonds than for issuers of identical conventional bonds. Furthermore, I find that the discount that the ECB applies to green bonds is substantially higher than the one it applies to conventional bonds. Taken together, these findings imply that, due to specific policy interventions by the ECB, borrowing through green bonds is more expensive than it could be.

In this paper, I engage with the broader scholarship on the political economy of central banking and climate finance. First, while the impact of central banks on financial market

yields and pricing has been widely studied (Abidi & Miquel-Flores, 2018; Andrade et al., 2016; De Santis, 2020; Eser et al., 2019; Galema & Lugo, 2021; Li et al., 2021; Pelizzon et al., 2023), I extend this by examining how central bank behavior specifically influences green bonds. Second, I explore how the institutional design of central banks shapes politico-economic outcomes (Ballard-Rosa et al., 2021; Beaulieu et al., 2012; Bodea & Hicks, 2015; Hix et al., 2010; Lombardi & Moschella, 2016; Mosley & Rosendorff, 2023). Finally, and perhaps most significantly, I contribute to the literature that explores role central banks can play in climate mitigation and adaptation and that highlight the limits of green central banking (Boneva et al., 2022; Dafermos et al., 2021; Kedward et al., 2024; Larsen, 2023; Matikainen et al., 2017; McConnell et al., 2022; Quorning, 2024; van 't Klooster & Fontan, 2020). By identifying a specific policy gap in the ECB's collateral framework, which undervalues green assets, I propose a route toward improving ECB performance in this area.

The paper proceeds as follows. First, I introduce the empirical setting, explaining the nature of green bonds and the importance of green bonds trading at a premium to mobilize additional finance for green projects. Next, I theorize how the ECB's monetary policy interventions affect green bond pricing. Following that, I detail the variables, data sources, and methods used in my analysis. Finally, I present the results, highlight the theoretical and empirical contributions, and discuss implications for policy and future research.

2.2 The Green Bond Premium

Green bonds refer to debt securities issued to raise capital. The structure of green bonds is essentially identical to that of conventional or 'plain vanilla' bonds. The structural similarity between green bonds and mainstream alternatives has led them to be labeled 'boring' (Bigger & Millington, 2020). The main difference between plain vanilla bonds and green bonds lies in the use of proceeds. The Green Bond Principles (GBP) of the International Capital Markets Association (ICMA) define green bonds as 'any type of bond instrument where the proceeds will be exclusively applied to finance or re-finance, in part or in full, new and/or existing eligible green projects' (ICMA, 2017). The second important difference between green bonds and conventional bonds is that, in addition to the standard credit rating process, green bonds can be issued with varying degrees of environmental assurance certification to avoid greenwashing (CBI, 2021; Jones et al.,

2020; Simeth, 2022). Currently, green bonds are predominately denominated in Euros (Figure 2.1), and corporate issuers have the largest share of the market (Figure 2.2).

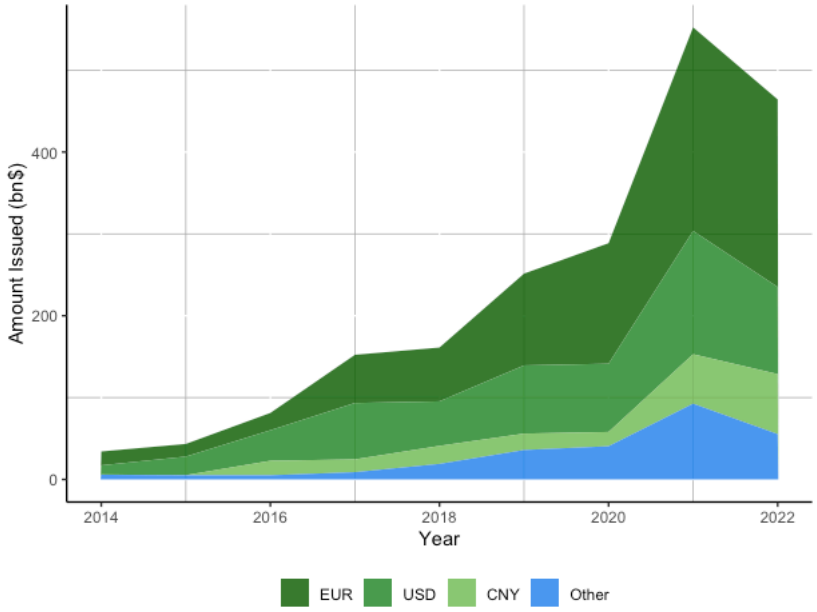

Figure 2.1. Green Bond Issuance by currency

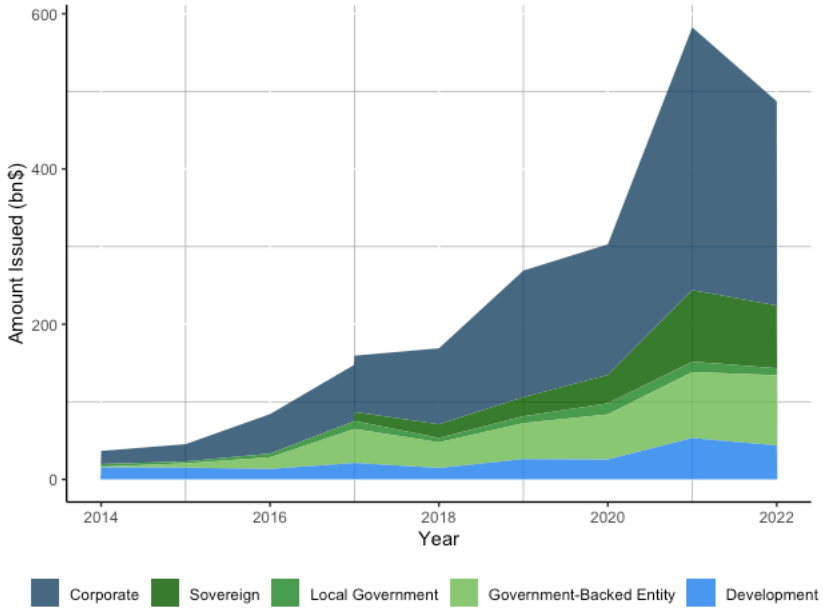

Figure 2.2. Green Bond Issuance by Type of Issuer

While the size of the green bond market pales in comparison to the conventional bond market, other types of climate finance, such as the global carbon markets, the REDD carbon offsets, and the Green Climate Fund, appear as 'drops in the bucket of climate finance' compared to the green bond market (Bigger & Millington, 2020, p. 607).

2.1.1 Green Bond premium and additionality

Actors who currently issue green bonds have little trouble raising capital—whether through green or conventional bonds (Jones et al., 2020). However, given that green bonds are touted as one of the solutions to address the need for funding climate change adaptation and mitigation projects, it is important to question whether they can allocate funds towards environmental projects that would not otherwise be funded. In other words, whether or not they are scaling up additional sources of finance (Agliardi & Agliardi, 2019). This is the so-called question of the 'additionality' of green bonds. The concept of additionality for green bonds has a similar logic to the one used for the Clean Development Mechanism (Michaelowa et al., 2009; Muller, 2009) and is defined as financing new projects that would have been impossible to fund through conventional bonds.

It is typically suggested that to achieve additionality, green bonds need to lower the cost of borrowing so that they can fund projects that are too expensive to finance through conventional bonds. For this reason, academic research on green bonds has focused, for the most part, on investigating the existence of a green bond premium or 'greenium' that investors are willing to pay for environmentally aligned debt (Cortellini & Panetta, 2021; MacAskill et al., 2021). The *greenium* is the difference in yield to maturity that a green bond has compared to an equivalent conventional bond. Thus, if a green bond has a lower yield to maturity than an equivalent bond, it is said to exhibit greenium (higher prices) because a higher price can be set. This implies that the borrowing costs the issuer faces are lower because investors are willing to accept lower yields in exchange for investing in a green project (Agliardi & Agliardi, 2019; Ando et al., 2022; MacAskill et al., 2021). The importance of green bonds having a 'greenium' would mean that environmentally aligned projects would be cheaper to fund via the debt markets than those from unlabeled debt, thus promoting additionality.

Theoretically, the green bond premium can either be positive or negative. On one hand, smaller issuances and less liquidity than conventional bonds can lead to positive premiums or lower prices for green bonds. On the other hand, the increase in demand for environmental, social, and governance (ESG) investments can lead to a greenium or lower prices for green bonds. In this sense, a greenium would provide new and additional climate financing as it would attract more capital at cheaper prices.

However, evidence of the existence of a *greenium* is controversial (MacAskill et al., 2021). Results vary depending on the universe of bonds that are analyzed, and the premium shows a widespread from negative to positive values. In the primary market, research finds evidence of a positive *greenium* effect where green bonds display yields 5 to 18 basis points (bps) lower than conventional bonds (Ehlers & Packer, 2017; Gianfrate & Peri, 2019; Kapraun et al., 2019), while research that finds evidence of negative greenium ranges from 0.4 to 4 bps higher than conventional bonds (Larcker & Watts, 2020; Partridge & Medda, 2020; Tang & Zhang, 2020) with Flammer noting that 'there is no noticeable difference between the yields of green versus brown bonds'(Flammer, 2021).[6]

On the other hand, analysis that finds evidence of a greenium effect on the secondary market shows a wider spread with results ranging from -63 bps to -2 bps (Dorfleitner et al., 2022; Nanayakkara & Colombage, 2018; Simeth, 2022; Zerbib, 2019) and authors finding negative greenium effects that range from 4 to 6 bps higher than conventional bonds (Bachelet et al., 2019; Hyun et al., 2021; Kapraun et al., 2019) and other authors finding that the greenium effect changes over time (Karpf & Mandel, 2018).

2.1.2 Determinants of the green bond premium

Beyond whether green bonds provide cheaper funding than conventional bonds, the literature on green bonds seems to be preoccupied with establishing the determinants of such an effect. In particular, the literature has a narrow focus and discusses only internal financial characteristics of bonds and environmental drivers that might lead investors to prefer one type of asset over the other, with no attention paid to some of the wider politico-economic factors that can influence bond prices.

In financial terms, all studies control for internal characteristics of bonds such as their size, coupon rate, maturity, credit rating, currency of issue, and type of issuer. In addition to this, given that the relationship between liquidity and yield spreads is well established (Zerbib, 2019, p. 44), most studies focusing on secondary markets analyze the effects of

[6] Basis point or bps are a widely used unit of measure in finance to show the change in the value or rate of a financial instrument. One basis point is equal to one one-hundredth of a percentage point (0.01%). For example, if the interest rate of an instrument increased by 1%, we could say that it increased by 100 basis points. Using basis points instead of percentages makes it more convenient to compare small changes and variations in financial percentages without introducing the complexity of using decimal points.

liquidity – measured as the bid-ask spread – on the green bond premium (Bachelet et al., 2019; Febi et al., 2018; Simeth, 2022; Zerbib, 2019) and find that, in general, higher spreads are correlated with higher yields.

In environmental terms, most studies are concerned with the effects of green label verification in the form of external reviews. This is important as it pertains directly to the question of whether green bonds can be used for funding non-environmentally friendly projects or as a tool for greenwashing (Flammer, 2021). One of the biggest challenges green bonds face at the moment is ensuring their environmental integrity to mitigate criticisms of greenwashing, given that if this were the case, investors would lose interest in the market altogether (Shishlov et al., 2016). As such, external reviews help address these concerns by ensuring transparency in the issuers' capability to deliver on their promises, as well as by assessing the 'greenness' of the use of proceeds and the management of proceeds through tracking and auditing, as well as through reporting on the environmental impacts of the projects (Bachelet et al., 2019; Dorfleitner et al., 2022; Simeth, 2022).

Apart from a few exceptions that address some external factors that might influence the green bond premium, such as tax incentives in the US Municipal Bond market (Burton, 2018) or for corporate bonds in India (Agliardi & Agliardi, 2019), the financial economics literature is mostly focused on internal financial and environmental characteristics of green bonds and pays little to no attention to wider politico-economic factors. By focusing on the role played by specific central bank policy interventions on green bond prices, I address this gap. Specifically, I probe the extent to which the ECB collateral framework and its valuation of haircuts influence green bond prices.

2.3 Theoretical framework. The role of the Euro system Collateral Framework

We know that central banks matter in shaping bond market outcomes and performance, such as yields, firms' behavior, and potential price distortions. However, there are relatively few insights into the likely relationship between central banking operations and green bond pricing. Drawing on the political economy scholarship of central banking and financial economics scholarship on green bonds, in this section, I theorize my expectations about the role that the ECB's monetary policy plays in green bond prices based on its eligibility criteria, its valuation of haircuts, and its implicit carbon bias.

Like all central banks, one of the ways in which the ECB creates and distributes money is by providing credit to private banks in the Eurozone. At the heart of this policy is the Eurosystem collateral framework (ESCF), which is the tool that determines how banks in the Eurozone get access to ECB money. The ECB provides credit to banks conditional on collateralization, that is, against a guarantee. First, this acts as a form of insurance to protect itself from counterparty risk in a similar way to how commercial banks, when lending mortgages, use houses as insurance in case the borrower fails to repay the loan. Secondly, the ECB provides credit against collateral because, as a central bank, it needs to act quickly when conducting monetary policy, yet uncollateralized lending is extremely time-consuming. Lending against collateral has been a basic principle of central banking since its inception, and the only limit to the amount of ECB reserves a bank can borrow depends on the amount of collateral that any particular bank can pledge (Barthélemy et al., 2018; Bindseil et al., 2017; Dafermos et al., 2021).

The type of collateral that the ECB and other central banks accept is a broad range of financial assets, and although these include nonmarketable assets like fixed-term deposits or credit claims, the vast majority of acceptable collateral, however, consists of marketable assets, namely, those that can be converted into cash on demand in financial markets (Bindseil et al., 2017; Dafermos et al., 2021). The ECB, in particular, has an especially large list of eligible collateral, with the number of individual securities over time ranging from 30,000 to 40,000, which are updated daily on the ECB webpage. While sovereign bonds account for approximately 50% of the total outstanding amount of the acceptable collateral pool, the ECB also has a long history of accepting other types of assets, such as local government bonds, supranational and agency bonds, traditional covered bonds, corporate bonds, and asset-backed securities (Nguyen, 2020; Nyborg, 2017; Pelizzon et al., 2023).

Empirical research on the potential effects of the ECB collateral framework on assets and access to funding shows consistently that the more favorable the collateral policy of the central bank towards a specific security, the more favorable financing conditions the borrowers have (Cassola & Koulischer, 2019; Mésonnier et al., 2022; Nguyen, 2020; Nyborg, 2017; Pelizzon et al., 2023). Of course, not all eligible assets are created equal, so the question of how central banks, and the ECB in particular, value eligible collateral will have an effect on bond yields in general and on the greenium of green bonds in

particular. As such, we next theorize our expectations concerning the effects of the ECB valuation of collateral on bond yields.

2.3.1 The ECB valuation of collateral

As a risk mitigation measure, the ECB needs to value the assets it accepts as collateral to ensure that the amount of central bank reserves borrowed against it does not exceed the actual value of the collateral in case the borrower defaults and the collateral it posted needs to be sold to recover the money lent (Bindseil et al., 2017). The essential risk mitigation tools that the ECB has at its disposal are marking-to-market on a constant basis, margin calls, and haircuts (Gabor & Ban, 2016; Pelizzon et al., 2023).

First, against criticisms that its collateral framework suppressed sovereign default-risk differences between countries in the Eurozone, which encouraged investors to treat German bonds and Greek bonds as having similar creditworthiness and thus weakened the fiscal discipline of member countries (Buiter & Sibert, 2005), the ECB uses market prices – marks-to-market – as a starting point for valuing all eligible marketable assets and updates the value regularly as asset prices fluctuate over time, thus minimizing price interferences and allocation practices. Secondly, if the value of collateral falls below a specific threshold, borrowers need to post additional collateral to make up the shortfall – or meet the margin call – thus protecting the ECB from market fluctuations (Bindseil et al., 2017; ECB, 2015a; ESRB, 2017; Gabor & Ban, 2016).

Finally, and perhaps more interestingly, when accepting collateral, the ECB applies a discount, or *haircut*, in order to protect itself from a fall in its value. As such, a haircut establishes the amount of central bank reserves that a borrower receives in return for collateral and is defined as 'the difference between the security's price and the collateral value' (Brunnermeier & Pedersen, 2008). For example, if a borrower posts as collateral an asset worth €100 that has a haircut of 5%, then the borrower would only receive €95 worth of ECB funds (Cassola & Koulischer, 2019). As such, haircuts are a risk mitigation tool designed to protect the ECB from a fall in the value of collateral in case it is forced to sell the assets at a lower price than the one it had when it was originally posted as collateral (ESRB, 2017).

The ECB estimates the percentage of the haircut for each security in its list of eligible assets based on the residual maturity of the asset (shorter maturities mean smaller haircuts), the type of asset (bonds, for instance, have lower haircuts than asset-backed

securities), the type of issuer (sovereign bonds are subject to smaller haircuts than corporate ones), coupon type, and credit rating (sovereign bonds are subject to smaller haircuts than corporate ones), coupon type and credit rating(Adler et al., 2023; Barthélemy et al., 2018; Nguyen, 2020). However, the key overriding principle is that as the liquidity of an asset decreases, its haircut increases, as the goal is to calculate the amount of liquidity that can be backed by a particular asset in the case of default (Cassola & Koulischer, 2019; ECB, 2015a).

Theoretically, given that assets with lower haircuts are inherently more attractive because they can be translated into central bank funds at a higher rate, lower haircuts would be translated into lower yields. Empirically this has been tested by relatively few studies, although they all reach similar findings (Cassola & Koulischer, 2019; Nguyen, 2020; Nyborg, 2017; Nyborg & Woschitz, 2021).

Thus, haircuts have a significant relationship with bond yields and prices, and as such, it is important to investigate empirically their effect on the greenium of green bonds. Crucially, however, haircuts are determined directly by the central bank (in this case, the ECB) and not by the market. Thus, it has so far not been tested by most of the empirical research on greenium, which focuses only on the internal and market characteristics of bonds. Based on these insights, and to address this gap in the literature, I theorize the following hypothesis:

H1. Higher haircuts in the ECB collateral framework lead minimize the *greenium* effect for Green Bonds.

Nonetheless, the ECB collateral framework operates under a policy of market neutrality, so it needs to ensure it does not distort the market where collateral trades. However, this neutrality has been called into question, particularly concerning the ECB's role in addressing the environment. This debate is of special importance when discussing the issue of green bond prices, and as such, we next theorize our expectations regarding the treatment of green bonds by the ECB.

2.3.2 Torn between market neutrality and anti-green bias.

As mentioned previously, the ECB, as well as other central banks, operates under a policy of market neutrality. In theory, this entails that the ECB's private sector asset purchases

are done in proportion to how much they are worth in the market and that loans against collateral do not have a substantive influence on the markets where collateral trades. For this reason, haircuts need to be estimated to appropriately reflect market size, liquidity, and credit risk over a "liquidation horizon, which is long enough to ensure it does not have a negative impact on prices through liquidation" (Aubrechtova et al., 2023). In other words, market neutrality means that the ECB seeks to implement monetary policies in a way that does not give preferential treatment to specific sectors or asset classes within the financial markets, to avoid distorting market dynamics (Bindseil et al., 2017).

However, the principle of market neutrality has been widely criticized in relation to the ECB's climate ambition. For instance, given that the ECB's asset purchases are done in proportion to the market index of the securities, this entails, in practice, a bias towards carbon-intensive sectors, as these tend to be capital-intensive (Boneva et al., 2022; Dafermos et al., 2021; Jourdan & Kalinowski, 2019; Matikainen et al., 2017; Monnin, 2018; Papoutsi et al., 2021; van 't Klooster & Fontan, 2020). This bias lowers the borrowing costs in carbon-intensive sectors, and it has been argued that it leads to higher overall carbon emissions (Schoenmaker, 2021).

For the most part, studies that have tested empirically this carbon bias have focused on the role that collateral eligibility criteria played during the ECB Corporate Sector Purchase Program (CSPP) – part of the broader Quantitative Easing program that the ECB conducted between June 2016 and December 2018 – (Jourdan & Kalinowski, 2019; Matikainen et al., 2017; Papoutsi et al., 2021). However, the question of how haircuts help engrain this carbon bias in the framework has also been tested (Dafermos et al., 2021).

For instance, looking at the first year of the CSPP, Matikainen et al. (2017) find that 62.1% of assets bought by the ECB came from sectors that accounted for 58.5% of greenhouse gases emitted within the Eurozone. Studies looking at the whole period find very similar results (Jourdan & Kalinowski, 2019; Papoutsi et al., 2021). Focusing on haircuts, on the other hand, Dafermos et al. (2021) find that haircuts for non-carbon-intensive sectors are between 0.6 and 3.66 percent higher than those in carbon-intensive sectors thus creating less favorable financing conditions for such sectors.

While all these studies show that market neutrality leads to a carbon bias, none of them addresses the issue of how collateral eligibility criteria and haircuts affect labeled green bonds. Theoretically, this carbon bias could extend to green bonds and further lead to an anti-green bias, where the ECB collateral framework systematically differentiates green bonds only by the fact that they are labeled green. As such, I propose the following hypothesis.

H2. The ECB collateral framework systematically treats labelled green bonds in less favorable conditions than conventional bonds.

In the following sections, I explain the empirical setting of green bonds and the green bond premium, as well the research design I follow to test these hypotheses.

2.4 Research Design

2.4.1 Outcome and predictive variables

The outcomes of interest are variations of bond yields. For H1 I rely on bonds yield to maturity (or the anticipated return of a bond if held until maturity). For H2, the main outcome of interest is the green bond premium or *greenium.* I estimate the *greenium* as a yield spread, that is, the difference in yields to maturity of a green bond and a conventional bond. Conventionally, yield spreads are estimated by deducting the yield of one bond from the other and this difference is expressed in basis points. As such, I estimate *greenium* as the difference between the daily green bond yield to maturity (*mid*) and the one from a similar conventional bond according to the following equation:

$$\Delta y_{i,t} = y_{i,t}^{gb} - y_{i,t}^{cb} \quad (2)$$

Where $\Delta y_{i,t}$ is the *greenium* for the *i*th bond couple on day *t*, $y_{i,t}^{gb}$ is the yield to maturity of green bond *i* on day *t*, and $y_{i,t}^{cb}$ is the yield to maturity of a similar conventional bond *i* on day *t*. As mentioned, the green bond premium could take either a positive sign or negative signs. However, to achieve additionality, the *greenium* should take a negative sign in order to be able to fund climate aligned projects more cheaply than conventional bonds.

My main explanatory variables are the green bond label and the haircut spread. First, the green bond label is a dummy variable coded 1 if the bond is labelled green and 0 otherwise.

Secondly, the haircut spread is estimated similarly to the yield spread as the difference in haircut of a green bond and that of a similar conventional bond on the same trading day

$$\Delta Haircut_{i,t} = Haircut_{j,t}^{gb} - Haircut_{k,t}^{cb} \quad (3)$$

Where $Haircut_{i,t}^{gb}$ is the value of the haircut that the ECB assigns to green bond *j* of pair *i* on day *t,* and $Haircut_{k,t}^{cb}$ is the yield to maturity of a similar conventional bond *k* of pair *i* on day *t*.

2.4.2 Data sources and empirical strategy

The main source of data is the Refinitiv database. In addition to this, I use the ECB general collateral framework eligible assets database. First, I used the Refinitiv Government and Corporate Bonds Advanced Search application from which I extracted an initial sample of all active green and conventional bonds issued between October 2017 – when sovereign green bonds were first issued – and May 2023.

To avoid the uncertainty of the impact that a non-constant coupon rating can have on the pricing at issuance and to construct a more homogeneous sample, I excluded bonds without fixed coupons – as they have non-constant coupons linked to a particular reference rate – and focus exclusively on plain vanilla bonds to control for the uncertainty that floating rates can have on prices at issuance (Gianfrate & Peri, 2019; Simeth, 2022). I then screened for duplicate bonds and those without International Securities Identification Number (ISIN) and removed them from the sample. To control for the impact that a lack of credit rating might have on a bond's price, I also excluded bonds without ratings. I relied on ratings provided by Moody's as it had the highest number of observations in the data set and complemented them with Fitch ratings when available. Then, for each green and conventional bond, I collected descriptive information such as issuer, issuer type, and currency. Furthermore, I collected several structural parameters to use as control variables such as coupon rate, date of maturity, original yield maturity to account for the pricing at issuance of the bonds, and amount issued given that substantial differences of these variables between bonds can have a significant effect on their yields (Zerbib, 2019). Finally, I collected daily observations of the mid yields as well as daily observations of the ask and bid prices of each bond as the bid-ask spread is a common proxy for estimating a bond's liquidity where a higher spread is associated with lower

liquidity(Adrian & Shin, 2010; Bachelet et al., 2019; Febi et al., 2018). Bonds with missing values were excluded from the sample. The resulting database consists of 28,137 bonds of which 999 are labelled green.

I merge this database with data from the European Central Bank eligible asset database, which lists all eligible marketable assets and is updated on a daily basis. Specifically, for each bond I extracted whether it was included in the framework or not, and, for bonds that did meet the eligibility criteria, I also extracted daily haircut observations. Table 2.1 summarizes the variables I use and their descriptions.

Table 2.1Description of Variables

Variable	Description
ISIN	International Securities Identification Number for the bond
Issuer	Name of issuer
Amount	Amount issued in US dollars
Coupon	Coupon rate of the bonds
Maturity	Maturity of a bond in years
Currency	Currency of amount issued
Rating	Credit rating (Aaa = 21; BBB = 12)
Pask	Ask price
Pbid	Bid price
Liquidity	Bid-Ask spread
Yield	Mid yield of a particular bond
Haircut	Haircut percentage that the ECB assigns to a specific bond

A common strategy for estimating the treatment effects with panel data is with two-way fixed effects regressions. However, the difference between the amount of conventional bonds versus green bonds leads to an imbalance in covariates which, in turn, would lead to inefficient estimations of causal effects and higher degrees of model dependence (Imai et al., 2023; King & Nielsen, 2019). Moreover, to effectively estimate the treatment effect of the green label on a bond it would be necessary to compare the outcome variable of a bond had it been designated as green and of the same bond if it had been issued conventionally. However, this analytic approach requires that we observe each bond as being priced as both green and conventional, which is not possible. Finally, practical barriers prevent us from collecting the data through experimental design (Bachelet et al., 2019; Gianfrate & Peri, 2019).

In order to solve these issues, matching methods are a common tool for improving the validity of causal studies where counterfactual analysis or experiments are not possible by way of finding 'hidden randomized experiments' within an observational dataset and, as such, have become increasingly popular for comparing the returns of green bonds *vis-à-vis* conventional bonds (Bachelet et al., 2019; Gianfrate & Peri, 2019; Hyun et al., 2021, 2021; Simeth, 2022; Zerbib, 2019).

In essence, matching preprocesses data by 'pruning' observations that have no close matches on covariates in both the control and treated groups so that estimating the average treatment effect on the treated (ATT) is less of a function of modelling decisions, that is, less model dependent. Also, by creating pairs of observations that have essentially the same properties except for the treatment variable, it avoids the issue of selection bias. Finally, by removing heterogeneity such models are more efficient estimators of the ATT (Iacus et al., 2012; Imai et al., 2023).

Table 2.2 Bond Matching Characteristics

Bond characteristic	Matching parameters
Amount issued	±400%
Coupon	±0.25%
Issue Date	±4 years
Maturity	±4 years
Currency	Same
Issuer	Same
Credit rating	Same

To this end, first I match each green bond in the dataset with a conventional bond to its nearest neighbor in terms of selected characteristics. I specify the matching requirements as specified in Table 2.2 to control for individual characteristics and credit risk of each bond.

Zerbib tested the robustness of these parameters and found not only that they are efficient in balancing the covariates of the observations but also that more stringent matching constraints degrade the quality of the post-matching estimation (Zerbib, 2019, pp. 49-50). As such, these parameters have become widely accepted in subsequent analyses of bond prices (Bachelet et al., 2019; Simeth, 2022). Moreover, in order to control for any bias induced by potential mismatches, I control for variables that are not exactly matched in the subsequent econometric analysis. Despite the strictness of these parameters, I identified 265 pairs of green and conventional bonds in which the only significant

difference is the green label. The matching process resulted in much more balanced covariates. To test the hypotheses I theorized, I further narrow the database to include only those bonds included in the ECSF and with haircuts available. This narrowed the sample to 111 pairs of bonds (Table 2.3). [7]

Table 2.3 Descriptive Statistics

Green Bonds	N	Mean	St. Dev.	Min	25th Perc.	75th Perc.	Max
Yield	43,565	1.95	1.63	-0.86	0.32	3.32	6.95
Haircut	43,565	9.52	6.85	0.90	3.60	14.90	30.50
Liquidity	43,565	0.35	0.27	-1.02	0.16	0.44	3.72
Coupon	43,565	0.90	1.01	0	0.01	1.2	5
Size ($ MM)	43,565	2149.85	3728.48	11.23	561.35	1122.70	17615.58
Maturity	43,565	9.04	4.63	2.00	5.42	10.01	30.02
Days to Maturity	43,565	2,737.67	1,702.11	61	1,540	3,404	10,573

Conventional Bonds	N	Mean	St. Dev.	Min	25th Perc.	75th Perc.	Max
Yield	43,565	1.97	1.63	-0.83	0.35	3.34	7.08
Haircut	43,565	8.83	7.24	0.00	3.00	13.20	31.50
Liquidity	43,565	0.34	0.29	-1.99	0.15	0.43	4.96
Coupon	43,565	0.87	1.01	0.00	0.01	1.30	5.25
Size ($ MM)	43,565	3320.19	7290.78	11.23	561.35	1295.48	31435.60
Maturity	43,565	9.08	4.62	2.00	5.25	10.51	30.96
Days to Maturity	43,565	2,647.91	1,704.94	32	1,469	3,297	11,304

The main dependent variable in hypothesis one is the greenium effect or green bond premium that a green bond shows. I estimate the greenium as the daily yield spread between a green bond and its matched conventional bond as defined in Equation 1. As mentioned previously, this green bond premium can be negative (*greenium*) or positive (higher yields). To test my first hypothesis, I use the following model:

$$\Delta y_{i,t} = \beta_0 + \beta_1 \Delta Haircut_{i,t} + \beta_1 \Delta Liq_{i,t} + \sum_i \Delta\beta_i + \gamma_n + \eta_y + \epsilon_{i,t} \quad (4)$$

Here, $\Delta y_{i,t}$ is greenium defined as in Equation 1. Thus, $\Delta Haircut_{i,t}$ is my main explanatory variable and is defined as the haircut spread of a matched bond couple *i* on trading day *t* as in Equation 2. Conversely, $\Delta Liq_{i,t}$ is the liquidity spread of a matched

[7] Given that inclusion in the ECSF carries an 'eligibility premium', In the appendix I test whether this 'eligibility premium' is more important to achieving additionality than the 'green bond premium'.

bond couple *i* on trading day *t* and the same for the control variables included in $\sum_i \Delta\beta_i$ which includes the set of bond characteristics that were not matched exactly such as issue amount, maturity, coupon, and credit rating. These controls are used throughout the financial literature on bond pricing (Bachelet et al., 2019; Kapraun et al., 2019; Simeth, 2022; Zerbib, 2019). I also include issuer (γ_n) and yearly (η_y) fixed effects to control for any unobserved heterogeneity. Finally, $\epsilon_{i,t}$ is the stochastic error term clustered at the individual bond level.

To test the second hypothesis the dependent variable is the haircut that the ECB applies to each bond in its collateral framework with the following model:

$$Haircut_{i,t} = \beta_0 + \beta_1 Green\ Bond_{i,t} + \sum_i \beta_i + \gamma_u + \eta_y + \epsilon_{i,t} \quad (5)$$

Where $Haircut_{i,t}$ as mentioned, is haircut that the ECB applies to each bond on each trading date. The quantity of interest is $\text{Green}_{i,t}$, a dummy variable indicating whether the bond is labelled green or not, in order to test for the effect that being labelled green has on the ECB's valuation of haircuts. Finally, $\sum_i \beta_i$ is a set of control variables to account for the other factors that the ECB uses to determine the degree of haircut value for each security. According to Article 2 of the Haircut Guideline of the European Central Bank, the percentage of the haircut is determined by the type of issuer, the residual maturity, the coupon structure, the credit quality, and the liquidity category of the asset (Adler et al., 2023; Nguyen, 2020). Given that the sample of bonds consists only of plain vanilla bonds with fixed coupons, I control for differences in liquidity, residual maturity, and rating.[8] Finally, for completeness and robustness, I leverage the fact that matching allows us to compare the effect of the treatment variable with a simple difference in means by testing these differences in both the haircut value and haircut spread between green and conventional bonds.

In addition to this I also run several robustness checks to test the soundness of my research design. Specifically, I test alternative specifications of the Liquidity Category (Appendix 2.B) as well as splitting the sample in two time periods: for bonds prior to the

[8] Given that the matching procedure would have controlled for differences in liquidity category as it would match bonds from the same issuer, I diverge from the ECB's approach and further control for liquidity defined as the bid-ask spread. For robustness, I estimate these alternative specifications in table Table A 2.

inflation crisis in 2022 and those after the inflationary crisis after 2022 and find similar results to those in the main text.

2.5 Results and discussion

I begin by showing in Table 2.4 the results from equation (3), which presents the effects that ECB haircuts have on the green bond premium (i.e., greenium), defined as the yield spread between a green bond and a matched conventional bond. [9] Higher haircuts lead to a negative greenium effect, as they result in green bonds having yield spreads that are 2.5 bps higher than those of conventional bonds. This offers statistically significant support for Hypothesis 1, which posits that higher haircuts negatively impact the green bond premium.

Table 2.4Haircut Effects on Green Bond Premium

	Green Bond Premium (Greenium)		
	(1)	**(2)**	**(3)**
Haircut	0.025***	0.047***	0.047***
	(0.008)	(0.011)	(0.011)
Issuer FE	✓	✓	✓
Year FE	✓	✓	✓
Liquidity	✓	✓	×
Full controls	✓	×	×
Observations	43,565	43,565	43,565
Bonds	111	111	111
R2	0.315	0.166	0.166

Note: Cluster standard errors in parentheses. * p<0.1, ** p<0.05, ***p<0.01

Looking at the effect that haircuts have on yields (as opposed to the effect that haircut spreads have on the green bond premium) reveals an interesting dynamic, as the effect of the haircuts offsets the potential effect of the green label. Figure 2.3 shows that while being labeled green leads to bond yields that are 6.1 bps lower (holding all other variables constant), it also shows that an increase in haircuts is associated with yields that are 5.9 bps higher. Thus, larger haircuts almost entirely minimize the greenium effect of green

[9] The full results appear in Table A.2.4 of the Appendix.

bonds, limiting the potential for additionality that such bonds can achieve. Conversely, the green bond label seems to offset the effect that higher haircuts have on the greenium effect. This explains why, despite having larger haircuts, green bonds have still been found to trade at lower costs in the literature.

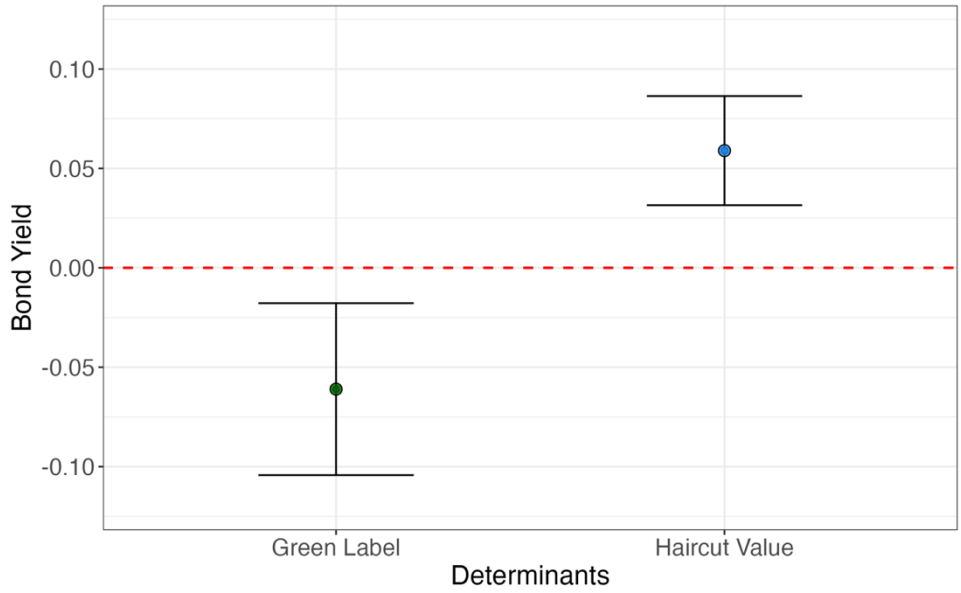

Figure 2.3 Effects of Green Label and Haircut on Yields

Finally, Table 2.5 shows the results of Equation (4) and illustrates the net effect that the green bond label has on the haircut that the ECB assigns to a green bond, compared to the haircut it assigns to an identical conventional bond. It shows that green bonds have a significant negative haircut premium, as the green label increases the spread by 66 bps. It is important to note that all models control for differences in liquidity, ensuring that the difference in yields and haircuts cannot be explained by green bonds showing lower levels of liquidity. [10]

Table 2.5 ATT of Green Bond on Haircut

	Haircut Value		
	(1)	**(2)**	**(3)**
Green Bond	0.664**	0.661**	0.687**
	(0.285)	(0.283)	(0.309)
Issuer FE	✓	✓	✓
Year FE	✓	✓	✓
Liquidity	✓	✓	×
Full controls	✓	×	×
Observations	87,130	87,130	87,130

[10] The full results appear in Table A2.6 in the Appendix.

Bonds	222	222	222
R2	0.21	0.06	0.02

Note: Cluster robust standard errors in parentheses. * p<0.1, ** p<0.05, ***p<0.01

For robustness, Figures 2.4 and 2.5 display the differences in means in haircuts (Figure 2.4) and haircut spreads (Figure 2.5) between green and conventional bonds. Relying on a two-sample t-test, the results reveal a statistically significant difference in means ($p < 0.001$), with green bonds having a higher mean haircut (M = 3.36) compared to conventional bonds (M = 3.11), and a higher mean haircut spread for green bonds (M = 0.1) compared to conventional bonds (M = -0.1). Taken together, these findings provide significant support for Hypothesis 2.

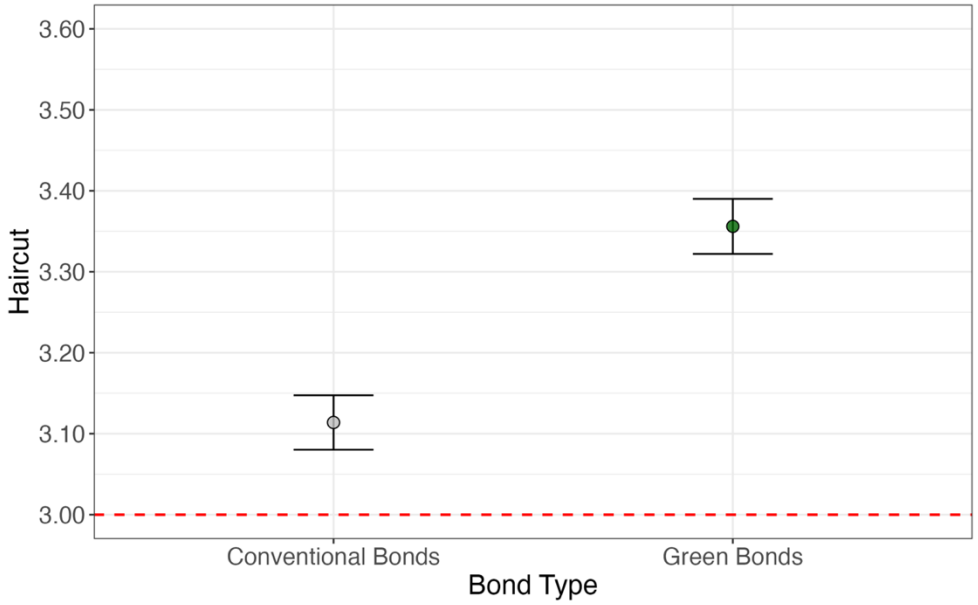

Figure 2.4 Difference in Mean Haircut Value

As a corollary, the results of Hypotheses 1 and 2 support the theoretical distinction between carbon bias and anti-green bias. The ECB is contributing to green bonds having a less significant premium relative to conventional bonds, but this is not by supporting bonds issued in carbon-intensive sectors; rather, it is by systematically treating green bonds differently through more conservative haircut valuations.

All the results I present are consistent with previous theoretical and empirical research on the fact that the ECB's principle of market neutrality leads to a bias in favor of carbon-intensive sectors. It is argued that central banks need to move beyond a strict application of market neutrality in order to support climate targets. As such, there have been several

proposals on how the ECB could green its collateral framework by addressing this carbon bias (Dafermos et al., 2021; Jourdan & Kalinowski, 2019; Monnin, 2018).

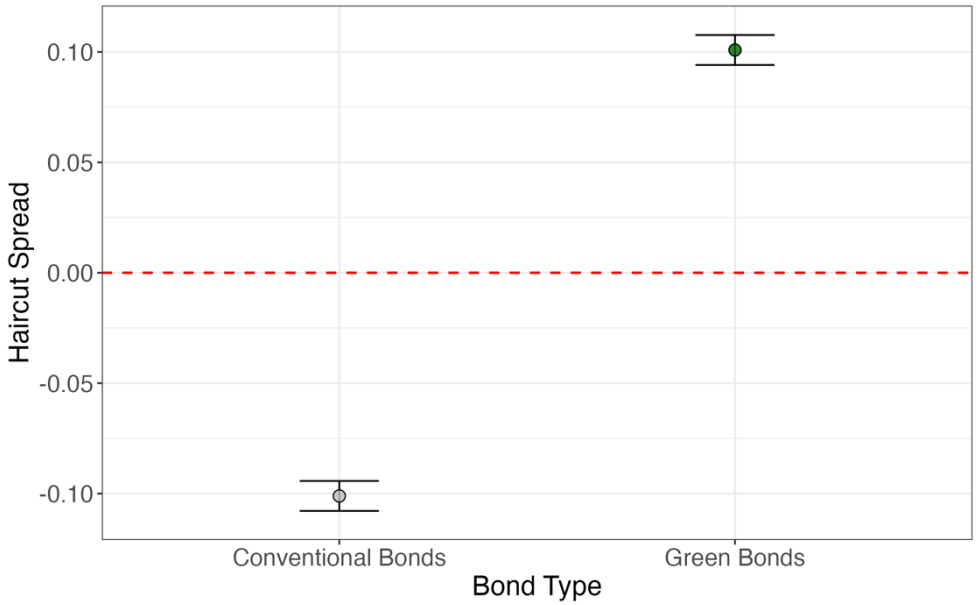

Figure 2.5 Difference in Mean Haircut Spread

However, addressing its carbon bias by punishing dirty assets alone will not be enough and might not be politically preferable. An important theoretical step evidenced by my results is to distinguish between two closely related but not entirely overlapping concepts: carbon bias and anti-green bias. While similar, it is more useful to think of them as two sides of the same coin: one leads to the favorable treatment of carbon-intensive assets, and the other leads to the unfavorable treatment of green assets. Thus, to green its collateral framework, the ECB would need to address both its carbon bias and its anti-green bias.

I find robust evidence that the ECB exhibits an anti-green bias by valuing the haircuts of green bonds demonstrably higher than those of conventional bonds included in its collateral framework, as theorized in Hypothesis 2. This, in turn, leads to a negative greenium effect by increasing bond yields, as expected by Hypothesis 1. Therefore, to effectively green its collateral framework, the ECB would not only need to replace carbon-intensive bonds but also address the unfavorable treatment of green bonds that results in higher borrowing costs. It could do this by targeting green bond prices and addressing the higher discounts that green bonds carry relative to conventional bonds in its collateral framework.

As my results show, haircuts have a significant impact on the green bond premium, as a 1% difference in the haircut spreads leads to a 2.5 basis point difference in bond yields, making borrowing through green debt more expensive. As mentioned previously, one of the selling points of green bonds is that they could attract additional finance to fund green projects by lowering the cost of borrowing. Thus, by properly valuing green assets equally to similar conventional bonds when assessing haircuts, the ECB can help further lower the financing costs of additional green projects. This would help jumpstart the green bond market in particular, as well as other types of environmental assets, such as ESG bonds or sustainability-linked bonds, especially since the demand for these types of assets has seemed to decline since 2023 (Bryan, 2023; Finacial Times, 2023; Webb, 2023).

Secondly, ECB haircuts are crucial because of their role in the European Repo Market and the broader importance of repo transactions within the global financial system. Private financial institutions also lend against collateral and apply their own haircuts through repurchase – or repo – agreements. A repo agreement is essentially a transaction where one party (the borrower) agrees to sell securities to another party (the lender) at a specified price, with the commitment to repurchase those securities at a pre-agreed price on a later date, typically overnight. Repo markets play a significant role in facilitating the flow of cash and securities in the financial system. In times of financial stress, they can contribute to financial stability by offering a relatively low risk means of raising cash without requiring the liquidation of assets. Therefore, repo transactions are essential for injecting liquidity into securities markets (ICMA, 2021).

On the other hand, one of the historical challenges in the secondary market trading of green bonds is their lack of liquidity. This is partly because many investors hold green bonds until maturity (Hyun et al., 2021). In this context, a well-functioning repo market for green bonds could help alleviate one of the main concerns related to their secondary market trading. This, in turn, could lead to a positive greenium in the secondary market, signaling investor preference for ESG investments and putting pressure on the primary market.

In this regard, there is a direct relationship between ECB haircuts and those in the European repo market, as the repo collateral eligibility criteria and haircut standards are strongly influenced by those set by the ECB. These ECB standards effectively introduce a de facto market cap for haircuts used in the repo markets (Bindseil et al., 2017, p. 50).

For instance, Nyborg (2017) estimates that more than 90% of the securities included in the General Collateral basket of Eurex, one of Europe's largest repo clearing houses, share the same haircut as the ECB collateral framework. Therefore, by integrating environmental considerations into the valuation of haircuts, the ECB could help address the liquidity constraints that green bonds have historically faced.

In contrast to research that advocates for central bank collateral frameworks to actively incentivize green investments and penalize carbon-intensive activities — by applying favorable haircuts to green assets and imposing higher haircuts on carbon-heavy ones to lower borrowing costs for environmentally friendly projects and foster investment in the green transition (McConnell et al., 2022) — I argue for a more conservative approach. As I have demonstrated, the ECB exhibits an anti-green bias in its collateral framework, with green bonds facing haircuts approximately 60 basis points higher than those of conventional bonds. Therefore, addressing this anti-green bias in the ECB's collateral framework could significantly increase the green bond premium and promote environmentally aligned projects, without requiring aggressive policy changes that might undermine its commitment to market neutrality. In this respect, I align with previous studies that suggest central banks should incorporate climate considerations, even if their mandates do not explicitly require it (Boneva et al., 2022; Dafermos et al., 2021, pp. 23-24).

The urgency of the climate crisis has pushed the ECB to recognize the need to move beyond a strict application of market neutrality. For example, Isabel Schnabel, a member of the ECB's executive committee, acknowledged that the current bias supports a "market structure that hampers an efficient allocation of resources" (Schnabel, 2021). In response, the ECB has pledged to incorporate climate change considerations into its monetary policy operations, including limiting the share of assets issued by carbon-intensive firms that can be pledged as collateral, and ensuring that all its policies align with the objectives of the Paris Agreement (ECB, 2022; Schnabel, 2023). However, addressing its carbon bias by penalizing "dirty" assets alone is insufficient. The ECB must also tackle its anti-green bias by actively promoting green assets. Unfortunately, as inflation concerns resurfaced, the ECB backtracked on its commitments and abandoned its strategy to decarbonize its bond portfolio. Moreover, with climate finance now integrated into the European Union (EU) budget, the ECB must align its monetary policy with the EU's climate goals if the Union is to achieve a comprehensive climate strategy (Oberthür &

Dupont, 2021; Rietig & Perkins, 2018). Failing to do so risks one EU institution undermining the efforts of another, potentially jeopardizing the EU's leadership in global environmental policy.

2.6 Conclusions

Existing scholarship underscores the critical role bonds play in the economy. Over the past several decades, particularly since the global financial crisis, bond markets have become central to the financial system, with governments and corporations relying on them to access funding. In fact, bond markets have been described as the engine driving the global economy (Wigglesworth, 2023). This study contributes to this body of work by exploring the politico-economic challenges faced by green bonds, particularly those not related to their financial characteristics. Drawing on theoretical expectations about the impact central banks can have on bond prices, I hypothesized that the ECB's collateral framework creates unfavorable borrowing conditions for green bonds through its eligibility rules and haircut valuation. Specifically, I distinguish between carbon bias and anti-green bias and theorized that, in addition to the ECB's known carbon bias, it may exhibit an anti-green bias by applying higher haircuts to green bonds compared to conventional bonds.

This paper demonstrates that ECB's collateral framework systematically disadvantages green bonds through more conservative haircut valuations. This "anti-green bias" contributes to an erosion of the greenium by raising yield spreads and undermining incentives for green bond issuance. The findings show that, beyond the ECB's already-documented carbon bias, its policies may be unintentionally misaligned with broader climate goals.

Empirically, I contribute to the emerging literature on green bond pricing by examining the impact of state agencies, particularly central banks, on bond prices by highlighting how institutions play a critical role in governing and influencing the greenium. This contribution extends to the broader literature on the political economy of climate change, demonstrating that some of the most influential climate policies are not explicitly climate-related by showing how central banks, in their capacity as market makers, can shape investor incentives in ways that are misaligned with the goals of the Paris Agreement.

My findings raise several important questions that warrant further investigation. First, the causal mechanisms behind the more conservative haircuts applied to green bonds remain unclear, suggesting that further research is needed to explore the underlying reasons for this discrepancy. Second, the role of other state agencies in influencing green bond pricing deserves attention. For example, the European Union's long-standing reputation as a climate leader (Biedenkopf et al., 2022) could play a significant role. Understanding the impact of role of EU-level initiatives like the European Green Deal and the EU Green Bond Standard on the green bond market is an important area for future research.

Finally, it is crucial to understand how the trading of green bonds in the repo market can affect not only their prices by influencing their haircut values but also introduce additional concerns regarding greenwashing. While using green collateral can enhance the liquidity and, by extension, the prices of green bonds, there is a risk that such collateral could also be employed to secure funding for environmentally harmful projects (ICMA, 2021). In light of ongoing concerns about greenwashing, further research is needed to explore these issues and assess how the repo market dynamics could contribute to or mitigate these risks.

Appendix 2.A The 'eligibility premium' vs the green bond premium.

Empirical research on the potential effects of the ECB collateral framework on assets and access to funding shows consistently that the more favorable the collateral policy of the central bank towards a specific security the more favorable financing conditions the borrowers have (Cassola & Koulischer, 2019; Mésonnier et al., 2022; Nguyen, 2020; Nyborg, 2017; Pelizzon et al., 2023). In particular, the few studies that explore the relationship between assets included in the framework and those that are not, find that the former show an 'eligibility premium' where eligible marketable assets showcase a yield decline of 4.6-20 basis points (bps) compared to non-eligible bonds (Pelizzon et al., 2023) and that non-marketable assets such as corporate loans eligible as collateral show lower spreads than those that are ineligible (Mésonnier et al., 2022).

Given that empirical research on 'greenium' paints a much more mixed picture regarding the effect of a bond's green label on its price (Cortellini & Panetta, 2021; MacAskill et al., 2021), it seems plausible that the 'eligibility premium' is more important to achieving additionality than the 'green bond premium'. Theoretically, given the mixed evidence of the impact of the green label on yields, the expectation is that the inclusion on the ESCF has a more significant impact on bond yields than being labelled green. To test this hypothesis, I rely on the following model:

$$y_{i,t} = \beta_0 + \beta_1 ECB_{i,t} + \beta_1 Green\ Bond_{i,t} + \beta_2 Liq_{i,t} + \sum_i \beta_i + \gamma_n + \eta_y + \epsilon_{i,t} \quad \text{(A.1)}$$

Where $y_{i,t}$ is the yield of bond *i* on trading day *t*, the main quantities of interest are $ECB_{i,t}$ $Green\ Bond_{i,t}$ which are dummy variables indicating if a bond *i* is included in the ECSF on day *t* and if it is labelled green respectively. $Liq_{i,t}$ is the difference between the bid price and the ask price of bond *i* on trading day *t* and functions as my main control variable to account for differences in liquidity affecting the bond yield. The variable $\sum_i \beta_i$ includes the set of bond characteristics that were not matched exactly such as issue amount, maturity, coupon, and credit rating. I also include issuer (γ_n) and yearly (η_y) fixed effects and $\epsilon_{i,t}$ is the stochastic error term clustered at the individual bond level. Table A.2.1 shows the descriptive statistics of the sample.

Table A 2.1Descriptive Statistics - full sample

Green Bonds	N	Mean	St. Dev.	Min	25th Perc.	75th Perc.	Max
Yield	123,590	2.38	1.71	-0.86	0.67	3.94	9.66
Liquidity	123,590	1.03	3.31	-1.10	0.23	0.77	30.41
Coupon	123,590	0.87	1.13	0	0.20	1	5
Size ($ MM)	123,590	911.53	2421.31	10.30	26.94	673.62	17615.58
Maturity	123,590	8.43	3.26	2.00	6.84	10.01	30.02
Days to Maturity	123,590	2,554	1,208	61	1,795	3,148	10,573

Conventional Bonds	N	Mean	St. Dev.	Min	25th Perc.	75th Perc.	Max
Yield	123,590	2.38	1.72	-2.00	0.65	3.88	9.94
Liquidity	123,925	0.96	3.20	-1.99	0.22	0.76	35.47
Coupon	123,925	0.84	1.07	0.00	0.23	0.94	5.25
Size ($ MM)	123,925	1336.97	4590.48	10.00	26.94	561.70	31435.60
Maturity	123,925	8.42	3.28	2.00	6.50	10.01	30.96
Days to Maturity	123,590	2,493	1,227	32	1,721	3,121	11,304

Table A 2.2 presents the coefficients of the effects that being eligible in the ECB and that being labelled green have on bond yields. Column (1) presents the model with full controls to account for the effect that issue size, maturity, coupon and credit rating have on yields. Column (2) controls only for the effect of liquidity and column (3) has no controls. In all specifications, collateral eligibility has a negative relationship to bond yields that is highly significant as bonds included in the ESCF have yields that are between 45-55 bps lower than those that are not included. On the other hand, the green label also shows a consistent negative relationship with bond yields, although this is smaller (between 4.4 and 4.7 bps).

Table A 2.2 Full Results for Model (A.1)

	Bond Yield		
	(1)	**(2)**	**(3)**
ECB	-0.459***	-0.555***	-0.558***
	(0.081)	(0.094)	(0.094)
Green Bond	-0.047	-0.045	-0.044
	(0.032)	(0.035)	(0.034)
Liquidity	0.022***	0.024***	
	(0.002)	(0.002)	
Issue Size	-0.127***		
	(0.033)		
Maturity	0.016*		
	(0.009)		
Coupon	0.193***		
	(0.043)		
Credit rating	-0.031		
	(0.023)		
Issuer FE	✓	✓	✓
Year FE	✓	✓	✓
Observations	247,180	247,180	247,180
Bonds	530	530	530
R2	0.05	0.03	0.02

Note: Cluster robust standard errors in parentheses. * p<0.1, ** p<0.05, ***p<0.01

Appendix 2.B Robustness Checks.

As mentioned in the text, when estimating the value of the haircut applied to bonds, the ECB relies on the type of issuer, the residual maturity, the coupon structure, the credit quality, and the liquidity category of the asset in order to control for three main types of risk: liquidity risk, market risk, and credit risk. In my models, I control for market risk and credit risk using the same parameters as the ECB where we differ is how we measure liquidity. I use the bid-ask spread as proxy of liquidity (and the respective difference of this spread to estimate differences in liquidity) while the ECB assumes that assets with similar characteristics have similar secondary market liquidity and are thus grouped in the same liquidity category.

I rely on the bid-ask spread as it is the most widely accepted proxy measure for liquidity (Helwege et al., 2014) and it allows for a more granular analysis. Conversely, the ECB uses liquidity categories for practicality as it accepts a wide variety of bonds as collateral and does not assess each individual bond's market depth and instead bonds with more homogenous characteristics are considered as part of institutional market segments.
To estimate valuation haircuts, financial assets with similar characteristics are bundled together. The ECB accepts many thousands of bonds as collateral and does not assess each individual bond's market depth. Instead, bonds are considered as part of institutional market segments with more homogeneous characteristics(Adler et al., 2023).As such, while the ECB's approach assumes the liquidity of each asset, I rely on the observable daily values the liquidity.

This liquidity categories are defined by the Haircut Guideline of the European Central Bank as follows (ECB, 2015b) :

1. **Category I**: Central government debt instruments and debt instruments issued by central banks.

2. **Category II**: Local and regional government debt instruments, Jumbo covered bonds, agency debt instruments and supranational debt instruments.

3. **Category III**: Traditional covered bank bonds, structured covered bank bonds, multi-cédulas and debt instruments issued by corporate and other issuers.

4. **Category IV:** Credit institution debt instruments (uncovered).

5. **Category V**: Asset-Backed securities.

Because the ECB's approach relies on assuming the liquidity of assets-based criteria that was preprocessed on the matching step such as issuer type or instrument type, relying on the bid-ask spread as measure for liquidity is more efficient and the preferred option. Nonetheless, for robustness, I perform alternative estimations to models (5) and (6) using the ECB's buckets in place of the bid-ask spread.[11]

Table A 2.3 Effect of Haircut controlling for liquidity categories

	Dependent Variable
	Haircut Value
Green Bond	0.560**
	(0.279)
Liquidity category	-4.090***
	(0.627)
Maturity	0.001***
	(0.0002)
Issue Size	0.019
	(0.593)
Issuer FE	✓
Year FE	✓
Observations	87,130
Bonds	222
R2	0.22

Note: Cluster Robust standard errors in parentheses. * p<0.1, ** p<0.05, ***p<0.01

The effect of the green label on the haircut remains substantial and with comparable values than the original estimation (56 bps vs 66 bps for the original model) and statistically significant.

[11] Where Category I = 5; Category II = 4; Category III = 3; Category IV = 2; Category V = 1.

Appendix 2.C Full Results.

Table A 2.4 Treatment effects for table 2.4 in Main Text

	Greenium (Yield Spread)		
	(1)	**(2)**	**(3)**
Δ Haircut	0.025***	0.047***	0.047***
	(0.008)	(0.011)	(0.011)
Δ Liquidity	-0.078***	-0.009	
	(0.025)	(0.031)	
Δ Issue Size	-0.00000		
	(0.00000)		
Δ Maturity	0.055***		
	(0.008)		
Δ Coupon	0.078		
	(0.055)		
Issuer FE	✓	✓	✓
Year FE	✓	✓	✓
Observations	43,565	43,565	43,565
Bonds	111	111	111
R2	0.315	0.166	0.166

Note: Cluster Robust standard errors in parentheses. * p<0.1, ** p<0.05, ***p<0.01

Table A 2.5 Full Results for Figure 2.3

	Bond Yield		
	(1)	**(2)**	**(3)**
Haircut	0.059***	0.066***	0.067***
	(0.014)	(0.013)	(0.012)
Green Bond	-0.061***	-0.057***	-0.057***
	(0.022)	(0.022)	(0.022)
Liquidity	-0.019	0.048	
	(0.089)	(0.094)	
Issue Size	-0.084*		
	(0.048)		
Maturity	0.013**		
	(0.006)		
Coupon	0.096***		
	(0.025)		
Issuer FE	✓	✓	✓
Year FE	✓	✓	✓
Observations	87,130	87,130	87,130
Bonds	222	222	222
R2	0.07	0.06	0.06

Note: Cluster Robust standard errors in parentheses. * p<0.1, ** p<0.05, ***p<0.01

Table A 2.6 Full results for Table 2.5 in the Main Text

	Haircut		
	(1)	**(2)**	**(3)**
Green Bond	0.664**	0.661**	0.687**
	(0.285)	(0.283)	(0.309)
Liquidity	1.699**	2.991***	
	(0.725)	(0.730)	
Issue Size	0.231		
	(0.647)		
Maturity	0.235***		
	(0.051)		
Coupon	0.987***		
	(0.346)		
Issuer FE	✓	✓	✓
Year FE	✓	✓	✓
Observations	87,130	87,130	87,130
Bonds	222	222	222
R2	0.21	0.06	0.02

Note: Cluster Robust standard errors in parentheses. * p<0.1, ** p<0.05, ***p<0.01

Appendix 2.D Different Time Periods

While the ECB frames its collateral policy in technical, risk-neutral terms, it operates within a political environment where inflation, energy costs, and fiscal concerns heavily influence policy discretion. The post-2022 macroeconomic landscape, marked by rising inflation and energy security crises, may have pressured the ECB to prioritize liquidity provision and financial stability, inadvertently reinforcing reliance on conventional assets. In other words: to prioritize the formal rules of its institutional design over its informal rules This reactive posture could explain the persistent haircut disadvantage for green bonds, especially if green assets were perceived as less liquid or more uncertain in pricing. In this context, the ECB's haircut framework might reflect political calculations about economic priorities, suggesting a latent preference for gradual transition pathways over more aggressive climate alignment. As central banks become more entangled with climate mandates, acknowledging these implicit political trade-offs becomes essential. Treating the ECB as an apolitical actor may obscure the real distributional consequences of its collateral design choices.

To assess whether the ECB's treatment of green collateral shifted over time to capture any heterogeneity in collateral policy before and after the energy and inflation crisis, divided the bond sample using a temporal split bonds issued in the period between 2017–2021 and those issued in 2022–2023. The descriptive statistics of the bonds in the first period can be found in Table A.2.6 and those of the second period in Table A.2.7.

In addition to this, I also produced new pre and post period regressions of equations (4) and (5) in the main text to estimate the Average Treatment Effect on the Treated (ATT) of haircuts on the greenium and of the green label on the haircut value. These appear, in Table A.2.8 and Table A.2.9 respectively.

Table A.2.7 Descriptive Statistics for Pre-2022 Period

Green Bonds	N	Mean	St. Dev.	Min	Max
Yield	14,713	0.21	0.55	-0.86	3.26
Haircut	14,713	9.86	7.42	1.20	30.50
Liquidity	14,713	0.32	0.22	-0.21	3.72
Coupon	14,713	0.73	0.65	0.00	2.13
Size ($ MM)	14,713	2,154.06	3,615.98	11,226.99	17,615.57
Maturity	14,713	9.13	4.14	4.00	29.26
Days to Maturity	14,713	2,889.10	1,557.01	635	10,573

Conventional Bonds	N	Mean	St. Dev.	Min	Max
Yield	14,713	0.24	0.63	-0.83	3.75
Haircut	14,713	8.93	8.31	0.00	31.50
Liquidity	14,713	0.30	0.25	-0.93	4.96
Coupon	14,713	0.69	0.62	0.00	1.88
Size ($ MM)	14,713	3,055.89	6,767.32	11,226.99	31,435.59
Maturity	14,713	9.50	4.27	3.92	30.96
Days to Maturity	14,713	2,920.14	1,610.54	606	11,304

Table A.2.8 Descriptive Statistics for Post-2022 Period

Green Bonds	N	Mean	St. Dev.	Min	Max
Yield	28,852	2.84	1.24	-0.59	7.08
Haircut	28,852	8.78	6.63	0.00	27.90
Liquidity	28,852	0.36	0.30	-1.99	2.70
Coupon	28,852	0.96	1.15	0.00	5.25
Size ($ MM)	28,852	3,454.969	7,540.28	11,226.99	31,435.59
Maturity	28,852	8.86	4.77	2.00	30.96
Days to Maturity	28,852	2,509.09	1,734.77	32	11,182

Conventional Bonds	N	Mean	St. Dev.	Min	Max
Yield	28,852	2.84	1.24	-0.64	6.95
Haircut	28,852	9.35	6.53	0.90	27.90
Liquidity	28,852	0.36	0.28	-1.02	1.90
Coupon	28,852	0.98	1.15	0.00	5.00
Size ($ MM)	28,852	2,147.69	3,784.62	11,226.99	17,615.576
Maturity	28,852	9.00	4.86	2.00	30.02
Days to Maturity	28,852	2,660.45	1,766.56	61	10,451

Table 2.9 Haircut Effects on Green Bond Premium by Time Period

	Green Bond Premium (Greenium)	
	(1)	**(2)**
Haircut	0.024***	0.027***
	(0.008)	(0.01)
Issuer FE	✓	✓
Year FE	✓	✓
Period	2017-2021	2022-2023
Full controls	✓	✓
Observations	14,713	28,852
R2	0.315	0.166

Note: Cluster robust standard errors in parentheses. * p<0.1, ** p<0.05, ***p<0.01

Table 2.10 Green Label Effect on Haircut by Time Period

	Haircut Value	
	(1)	**(2)**
Green Label	0.432**	1.090***
	(0.218)	(0.394)
Issuer FE	✓	✓
Year FE	✓	✓
Period	2017-2021	2022-2023
Full controls	✓	✓
Observations	14,713	28,852
R2	0.315	0.166

Note: Cluster robust standard errors in parentheses. * p<0.1, ** p<0.05, ***p<0.01

Splitting the sample in two time periods captures two distinct monetary policy regimes: pre-crisis quantitative easing and post-crisis normalization. The effect of haircuts on greenium remain consistent throughout the period as expected given that monetary policy should not affect the causal relationship between a haircut and the greenium. However, the results of the effects of the green label on the haircut suggest a widening haircut gap against green bonds in the latter period, consistent with a more conservative collateral stance. In the earlier period, the differential was smaller and statistically weaker, implying that the ECB may have deprioritized environmental considerations when inflation and stability risks surged. These results are largely consistent with my theoretical contribution of an 'anti-green bias' and the informal rules on institutions. In this case, despite initial commitments by the ECB to green its collateral framework, as inflation concerns resurfaced, the ECB backtracked on its commitments and abandoned its strategy to

decarbonize its bond portfolio. In this regard, its formal rule of price stability overrode its informal rule on green central banking.

Paper 3

3 The World Bank and 'Maximizing Finance for Development': talk the talk but not walk the walk.

Abstract

Can the World Bank effectively mobilize private finance to developing countries to support climate change transition? This paper demonstrates that the World Bank's market-based approach, exemplified by its Maximizing Finance for Development (MFD) approach, under-serves areas with a higher need for mitigation and adaptation finance. As such, MFD seems more aligned with donors' interests in climate finance burden sharing, than with recipients' needs. While the World Bank now 'talks the talk' of effectively leveraging private development finance, findings on MFD show that the organization does not yet 'walk the walk'. The paper uses Qualitative Comparative Analysis to show that the MFD agenda is leading the World Bank to systematically ignore countries with low levels of development, poor governance structures, and higher levels of climate risk. By showing that the Bank's MFD approach is insufficient to incentivize private investment in the countries that need adaptation and mitigation finance the most, this article contributes to the critical scholarship on the World Bank that highlights its tendency to behave more like a financial institution than as a development agency, to the detriment of the most vulnerable global populations.

3.1 Introduction

The climate emergency is the most pressing crisis facing the political world today. Global average temperatures have risen by 1.2°C from their pre-industrial averages, and significant changes are needed to limit warming to the Paris Agreement range of 1.5-2.0°C. Here, I extend the focus on international institutions and climate governance by systematically analyzing the role of the World Bank within the climate change regime. I specifically assess the tension between need- and market-based distribution of climate finance, as manifested through the Bank's Maximizing Finance for Development initiative.

The role of transnational climate finance in supporting climate justice remains heavily contested. The UN Framework Convention on Climate Change acknowledges the need for advanced industrialized states, in recognition of their role in causing 'loss and damage', to provide funds to global South partners (Vanhala & Hestbaek, 2016). However, criticism continues to be made of the failure to meet commitments, and the low targets being set (Roberts et al., 2021).

Here, I explore the extent to which the World Bank can function as a tool for effectively mobilizing private climate finance to the global South. To do this, I collect information from the World Bank project documents to identify cases that are aligned with this strategy and then use Qualitative Comparative Analysis to identify the 'causal pathways' that can promote or inhibit countries' engagement with MFD. I find that the World Bank has had a limited impact in mobilizing private finance to those developing countries with a greater need for climate change mitigation and adaptation finance. While the World Bank set out to prove that its borrowing countries could fund their mitigation and adaptation needs from the private sector, the MFD approach shows how difficult it is to align private finance with the needs of developing countries.

My contribution is twofold. Empirically, I show the limited impact of the World Bank's efforts to mobilize private finance to countries in need of funding. Specifically, I show that MFD systematically focuses on its more developed borrowers and those with lower levels of climate vulnerability. Secondly, scholarship on the World Bank points towards the existence of a long-standing tension at the heart of the organization given its nature of being both a bank and a development agency thus being forced to balance its donor's interests and its recipient needs. As such, whether lending for environmental or social purposes, the World Bank has been criticized for tending to privilege the bank-like

approach (Clegg, 2017; Gutner, 2002; Rich, 1994). Theoretically, I contribute to this debate by suggesting that the logic and rhetoric underpinning MFD is an attempt by the World Bank to 'square the circle' by identifying interventions that both reduce climate change vulnerability and offer a balance between risk and reward capable of attracting private investment. Overall, I argue that this market-based allocation promotes resource flows that are in tension with a more needs-based approach. This shortcoming of the MFD approach highlights the importance of alternative mechanisms to support climate justice. In developing this line of analysis, I use the following structure. In the first section, I review the literature on the structural tension between the World Bank's role as a bank and as a development agency. Then I provide a brief overview of private capital mobilization and the financial instruments the World Bank uses to this effect. The next two sections introduce, respectively, the variables and data sources used to operationalize the study and the analytic approach and methodology. In the final section, I present and discuss the results of my analysis, which indicate that MFD is not targeting the countries that are in most need of climate finance.

3.2 A theory of squaring the circle between finance and development

Scholarship on the World Bank identifies a historic tension between the organization's bank-like tendencies and the fulfilment of its overarching mission. After first reviewing key contributions in this regard, I engage with the work of Michaelowa et al. (2020) and Michaelowa and Michaelowa (2011) that, in the realm of climate change, the Bank was finding a modus operandi that supported a partial accommodation of these aims through lending on its account and through donor state-supplied Trust Funds. My empirical work serves to extend these insights, by showing that the attempts to catalyze and mobilize flows of private finance climate through MFD seem to demonstrate poorer targeting efficacy. In contrast to some World Bank own account lending and Trust Fund interventions, the Bank's turn to private finance seems to reproduce the privileging of the bank-like agenda over its development agency mission.

Private finance has since the late 2000s been presented as a vital pillar of climate change funding for the global South, to support adaptation and mitigation efforts and to acknowledge the wrongs from historic loss and damage caused by the global North. Given that the World Bank and other development finance institutions now constitute major mechanisms for facilitating climate finance to developing countries, attention has turned

to identifying and analyzing their emergent approaches (Brunner & Enting, 2014; Griffith-Jones et al., 2020; Mazzucato & Penna, 2016). To gain insight into possible constraints surrounding the achievement of this role, I turn to studies of the World Bank that offer critical interrogation of the organization's dual role as a development agency and financial institution.

Scholarship on the World Bank has been quick to notice that the organization struggles to cope with the fact that it has to act simultaneously as a development agency and a bank. Put differently, the World Bank struggles to balance its donors' interests and its recipient needs. As a development agency, it is required to focus its activities on fulfilling its twin goals of ending extreme poverty and promoting shared prosperity in a sustainable way. As a bank, however, it is driven by the structural need to pursue lending opportunities that have the potential to generate large revenue streams. Critics have identified a tendency of the World Bank to prioritize its bank-like side over its development agency-like side.

Among the environmental critics of the World Bank, this line of argument is closely associated with the works of , Gutner (2005b), and Wade (2002). For instance, Rich (1994) argues that the environmental reforms that occurred in the World Bank during the 1980s and 1990s were only a façade and that behind them, the Bank continued to do what it had always done. Gutner, on the other hand, argues the more demand-driven or 'bank-like' a development bank is, the less likely it is to be involved in efforts to help governments reform their policies in ways that benefit the environment. As such, she calls this internal tension between bank and development institution, the fundamental conflict between multilateral development banks (Gutner 2005). Finally, Wade (2002) argues that when the Bank strays too far from its bank-like activities for the benefit of empowering the poor and providing environmental protection it incurs the wrath of its donor member states. Parallel lines of critique have been made to operational areas beyond the environment. For instance, focusing specifically on the evolution of the Bank's approach to housing, Clegg Clegg (2017) demonstrates that over time the organization became notably more bank-like in its approach. Whereas through the initial decades of World Bank lending for housing, there had been a prominent focus on directly improving the conditions of lowest-income groups, more recently the prioritization of mortgage market expansion represented a drift toward interventions that would benefit mainly those on moderate and higher incomes with the ability to access such loans. Supplementary

insights from, Gamso and Dimitrova (2023) and Weaver Weaver (2008) also point towards systematic difficulties across the organization in prioritizing aspects of its development agency mission.

Scholarship on climate change regime complex highlights the benefits that can accrue from a decentered approach to addressing the global challenge, which sees multiple institutions flexibly altering practices to support and prioritize sustainable transition (Keohane & Victor, 2011). Building from these insights, I here identify additional challenges that may come through such decentered governance, with findings showing that institutional pathology in the institutions that participate in this regime complex needs to be guarded against.

Through this study, I build on the works of Michaelowa and Michaelowa (2011) and, more closely, Michaelowa et al. (2020). First, Michaelowa and Michaelowa (2011) adopt a 'donor interest (bank) vs recipient needs (development agency)' framework to explore the role that the World Bank plays in the carbon markets facilitated through the Clean Development Mechanism (CDM) and find that relative to private actors' behavior within carbon markets, the Bank's CDM displayed a marginally stronger tendency to invest in schemes that benefitted lower-income states, and that brought together emissions reductions with wider development impact. Elsewhere, Michaelowa et al. (2020) explore climate mitigation and adaptation trust funds in the World Bank in which donor states shape the distributional aims and processes. They find that the World Bank indiscriminately disburses its funds to higher-income countries, which makes sense in the case of mitigation funds, but which, in the case of adaptation funds, acts against the World Bank's claims of acting like a pro-poor development agency as it has not translated into financial support for the poorest and most vulnerable nations.

Overall, then, Michaelowa and Michaelowa (2011) and Michaelowa et al (2020) suggest that, through its CDM and Trust Fund operations, the World Bank had been delivering climate change-related interventions that displayed some alignment with its development agency mission, privileging (at least in part) the needs of climate vulnerable countries. The findings from this paper present a more negative assessment, showing that private financing flows through MFD tended away from lower-income and climate-vulnerable countries. First, Michaelowa et al. (2020) focus solely on Multilateral Development Bank trust funds. Trust funds are financing tools set up with contributions from one or more

non-governmental and private partners to address specific development priorities. Thus, while Michaelowa et al (2020) find this effect in the case of *ad hoc* climate finance allocation via trust funds, I extend our understanding of the bank vs development agency tension in the World Bank by showing that this dysfunction extends to the World Bank corporate strategy and is more systematically integrated into its core financing. In addition, crucially, my findings show contrasting results to those of Michaelowa et al. (2020). Specifically, when analyzing the role that climate vulnerability plays in disbursing adaptation finance, they find that vulnerability coefficients tend to be negative, suggesting that trust funds allocate more adaptation finance to those countries that are more vulnerable to climate change. By contrast, I find that the World Bank is unable to mobilize finance through MFD to countries with higher levels of climate vulnerability.

These findings can be read as representing a 'reversion to type', with the re-emergence of behavior that has been identified and criticized across a long history of the organization. These findings can also be taken to highlight the difficulty of influencing the flow of private finance; to risk-sensitive private financial institutions and investors, countries with lower incomes and higher climate vulnerabilities will likely represent less attractive opportunities. Consequently, the Bank's MFD agenda would seem to have catalyzed an extension of the bank-like versus development agency tension.

3.3 Mobilization of private capital to maximize finance for development

In 2015, members of the United Nations adopted the Paris Agreement which reaffirmed the commitment made by developed countries in Copenhagen in 2009 to support developing countries by mobilizing USD 100 billion and extending its deadline to 2025 OECD (2017). In addition, in 2015 they adopted the Sustainable Development Goals (SDGs), which recognized that eliminating global poverty and improving human well-being are inextricably linked with protecting the planet by tackling climate change. Given these lofty goals, the annual investment needed to fund sustainable development goals in the Global South was estimated to range between $3.3 trillion and $4.5 trillion (UNCTAD, 2014).

However, public levels of climate change-related investment and mobilization remained short of these goals, especially in a period where governments were seeking to reduce pressure on their balance sheets as a result of the global financial crisis. Consequently, the discourse focused on increasing private finance and the merits of private sector

involvement in infrastructure provision through Public-Private Partnerships (PPPs) as a potential solution to bridge this funding gap in mitigation and adaptation finance (Bisaro & Hinkel, 2018; Mathews et al., 2010; Moszoro et al., 2014; UNEP, 2016).

Given these problems, multilateral development banks (MDBs) became crucial for addressing the mitigation and adaptation needs of developing countries (Brunner & Enting, 2014; Griffith-Jones et al., 2020; Mazzucato & Penna, 2016). In this context, the World Bank Group (the Bank) adopted what they coined the 'cascade approach' as a three-step approach to creating markets and leveraging private financing. First, it provides policy de-risking to mobilize private finance by promoting policy reforms to address market failures and other constraints on private investment. Secondly, if risk remains high, it promotes financial de-risking through guarantees, other risk-sharing instruments, and public-private partnerships (PPPs). Finally, if the previous steps fail to create markets, it allows for the use of public resources (World Bank, 2017a, pp. 5-6). In 2017, the Bank instituted the cascade approach as their corporate strategy under the umbrella of 'Maximizing Finance for Development' (MFD).

Here it is important to note that MFD as a corporate strategy, is a coordinated approach of the World Bank to align the strategy of all of its institutions (namely, the Intranational Bank for Reconstruction and Development (IBRD), the International Development Association (IDA, the International Finance Corporation (IFC); and that of the Multilateral Investment Guarantee Agency (MIGA)) where private solutions are to be favored in all contexts and not just an *ad-hoc* instrument to finance projects in middle-income countries. For example, it also encompasses the IDA's Private Sector Window (PSW), a facility that places IDA resources under the control of the IFC and MIGA to maximize private sector investment in the poorest countries with a focus on fragile and conflict-affected states (World Bank, 2017b, p. 8; 2017c).

As I suggested previously, this new corporate strategy can be seen as an attempt by the World Bank to resolve the tension between its dual role as a development agency and financial institution. On the one side, it addresses recipient country needs by helping them bridge the current funding gap by optimizing limited development resources by attracting private sector financing and solutions that can provide value for money. On the other hand, it addresses its donor interests by mobilizing private capital to areas that are commercially sustainable using guarantees and other instruments that help mitigate the risks that investors would face so that these investments can provide value for money

(World Bank, 2017b, pp. 1-2) As such, it adopts a 'market-based understanding of sustainability' (Park, 2010) geared to maximizing both financial and environmental returns on investments in a win-win scenario by crowding in private investment to optimize the impact of the limited public resources available in order to address the investment gap at no cost to society (Cordella, 2018).

However, this attempt by the bank to solve its bank and development agent tension mirrors the logic of statecraft through derisking. Here the dilemma is between public and private investment where it is argued that public investment alone cannot meet the levels of climate-related investment, but equally that private finance alone cannot and will not invest in such areas given the risks they pose. The derisking state solves this dilemma through partnerships where public funds are used as risk-sharing instruments to subsidize private finance (Gabor, 2021). However, as I have shown, this partnership has had limited success in resolving both of these dilemmas.

With MFD, the Bank applies this derisking logic through two approaches. First, the mobilization of private capital (PCM) where the Bank uses the assets of its balance sheet to support the financing of projects but funding does not flow onto its balance sheet, and catalyzation of private capital (PCC), which is focused on improving countries' business environments through advisory work or development loans focused on policy reforms to liberalize their capital markets or other reforms to open up markets (IEG, 2020, p. 11). On the other hand, the Bank's PCM approaches are more intricate and can be one or multiple of the following instruments: mobilizing debt by acting as lead lender in a loan syndicate or through its Managed Co-Lending Portfolio Platform (MCPP) in which it pools private resources to use in loans; mobilizing equity through equity syndication or through the IFC's Asset Management company which functions similarly to the MCPP platform but in the case of equity; mobilizing bonds either through the issue of local currency bonds or through its Green Bond Fund which the World Bank launched in partnership with asset manager Amundi; mobilizing though full or partial guarantees to de-risk private investment, and through advisory mobilization through Public-Private Partnerships (PPPs).

The subsequent sections elaborate on the independent variable or 'outcome' that I am trying to explain, the sources of data underpinning the main explanatory variables, and the analytic approach I follow.

3.4 Data and data sources

The main outcome I am trying to explain is the volume of climate financing flowing to particular countries through the World Bank's MFD initiative. There are, however, several barriers to operationalization. World Bank databases neither systematically identify cases that are targeted at generating climate change impacts, nor identify projects that align with the MFD agenda. Furthermore, while some World Bank projects include specific components to address climate change, in other cases these are embedded alongside other objectives as co-benefits and so are not classified as either mitigation or adaptation projects. Given the importance of climate co-benefits as incentives for developing countries to adopt climate-aligned projects (Hochstetler, 2020) it was important to include those projects with climate co-benefits that were not classified with specific climate components as well.

To mitigate some of these issues, and in line with Eisenstadt et al. (2021) and Michaelowa et al. (2020) I deployed a keyword-matching approach to identify the universe of MFD lending that was meaningfully targeted at climate change. Where project documentation text noted climate adaptation or mitigation as a primary target or as a significant co-benefit, I classified a project as representing a climate finance flow. Where project documentation text identified any of the PCM or PCC instruments from Table 1 as the main sources of funding, I classified the project as aligned with the MFD agenda. This approach makes it possible to estimate the focus of the projects and in line with the literature on aid allocation and climate policy (Bagchi et al., 2016; Knill et al., 2009), I employ this approach rather than focusing on disbursements to better capture World Bank intent given that disbursements (along with other policy outputs) can be affected by several additional factors. Finally, to move from an absolute measure of financial flows to one that was more meaningfully comparable across countries, I recalibrated the climate-aligned MFD figure as a proportion of total World Bank climate change projects in a country.

To specify the universe of cases, I drew on three of the Bank's diagnostic tools - the Country Partnership Frameworks (CPFs); the Country Private Sector Diagnostics (CPSD); and Infrastructure Sector Assessment Programs (InfraSAPs) and focused only on those with an explicit intention of applying the MFD tools in the country on sectors typically associated with climate change. I identified these through an iterative keyword-matching

process to incorporate all the relevant sectors. Specifically, the sectors I reference are energy, sustainable agriculture, water management, resilience to climate shocks, sustainable fisheries, green housing, transport, waste management, and sustainable tourism. The country case selection appears in Table 3.1 and the resulting distribution can be seen in Figure 3.1.

Table 3.1Case Study Sample Selection

Country	Country Code	Region	Diagnostic Tool
Argentina	ARG	LCR	CPF
Benin	BEN	AFR	CPF
Burkina Faso	BFA	AFR	CPF, CPSD
Burundi	BDI	AFR	CPF
Cambodia	KHM	EAP	CPF
Cameroon	CMR	AFR	CPF
Ecuador	ECU	LCR	CPF
Egypt	EGY	MENA	InfraSAP
Ethiopia	ETH	AFR	CPF, CPSD
Ghana	GHA	AFR	CPF, CPSD
Guinea	GIN	AFR	CPF, CPSD
India	IND	SAR	CPF
Madagascar	MDG	AFR	CPF
Mauritania	MRT	AFR	CPF
Mauritius	MUS	AFR	CPF
Myanmar	MMR	EAP	CPF, CPSD
Nepal	NPL	SAR	CPF, CPSD
Niger	NER	AFR	CPF
Papua New Guinea	PNG	EAP	CPF
Paraguay	PRY	LCR	CPF
Seychelles	SYC	AFR	CPF
Solomon Islands	SLB	EAP	CPF
Tanzania	TZA	AFR	CPF
Thailand	THA	EAP	CPF
Vietnam	VNM	EAP	CPF
Zambia	ZMB	AFR	CPF

AFR: Africa; EAP: East Asia and the Pacific; LCR: Latin America and the Caribbean; MENA: Middle East and North Africa; SAR: South Asia. CPF: Country Partnership Framework: CPSD: Country Private Sector Diagnostics; InfraSAP: Infrastructure Sector Assessment Program

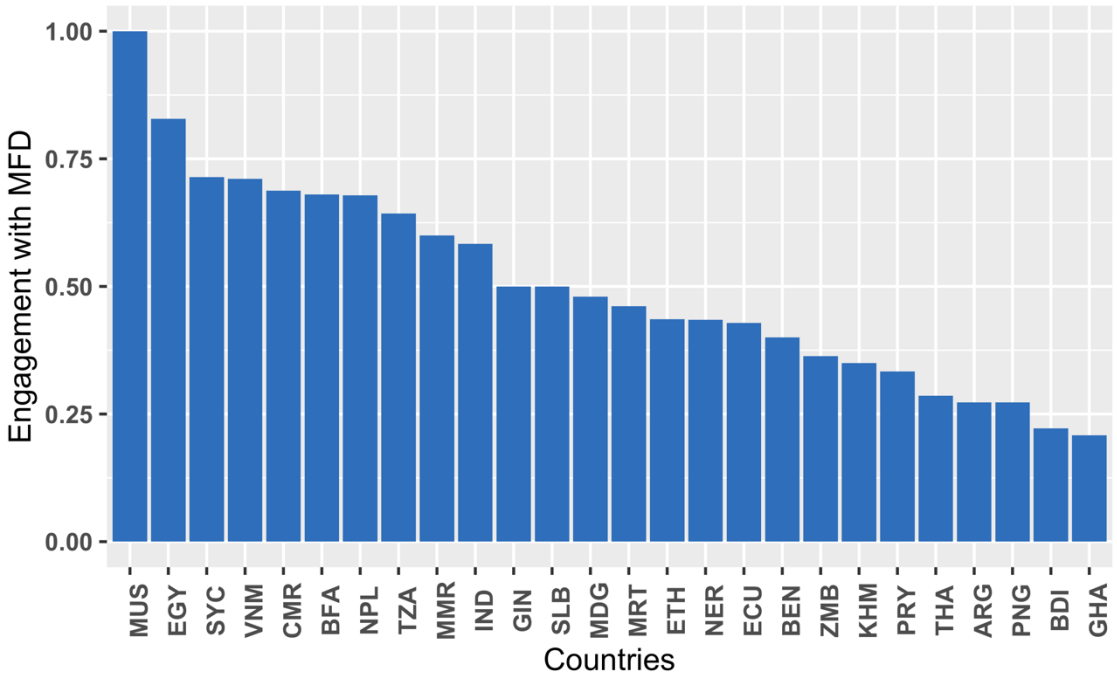

Figure 3.1Variation in MFD Engagement

First, I test a series of macroeconomic conditions. Economic development has been identified as a factor linked to environmental performance (Bayer et al., 2015; Lesnikowski et al., 2013; Liefferink et al., 2009; Massey et al., 2014; Tobin, 2017). Here we could expect that countries with higher available national resources may be more willing to allocate money to climate issues and, as such, a lack of financial resources derived from underdevelopment can be seen as a barrier to climate-aligned policies. As such, I expect wealthier countries to have higher participation in MFD.

Related to this condition, the association between a developed financial sector and a climate-aligned developed has been noted previously (Ng & Tao, 2016; Tian, 2018). As such, given that the World Bank prefers to use complex financial instruments such as blended finance and PPPs that countries with under-developed financial sectors might lack the capacity to work with (IEG, 2020, p. 73), theoretically, then, the more financially developed country is, the more engagement with MFD is expected to have.

Thirdly, MFD prioritizes private investment in place of public investment to optimize the limited fiscal space that indebted countries might have (World Bank, 2017b). Moreover, given that high levels of debt-to-GDP ratio are associated with a lack of efficiency of government spending (Abiad et al., 2016) it is plausible to expect that countries with

higher levels of debt will engage more with MFD to maximize their strained public finances.

Lastly, given that, in theory, a country with a more hospitable investment climate can mobilize more capital given that private investors have a lower boundary for the risk they can assume (Afonso et al., 2007). I theorize that countries with better investment climate will have greater participation in MFD.

I also test conditions regarding the institutional makeup of states given that state institutions can play important roles as either enablers or barriers of climate-aligned development. In this regard, given that characteristics commonly attributed to effective governance such as the absence of corruption, the rule of law, a strong civil society, political stability and state capacity appear to be necessary conditions for robust environmental policies (Christoff & Eckersley, 2011; Eisenstadt et al., 2019; Fredriksson & Svensson, 2003; Povitkina, 2018), I expect that countries with higher degrees of governance have more engagement with MFD. Finally, given path dependence, we can expect that if states are implementing certain infrastructure policies, they will be more open to doing so again in the future (Steen & Hansen, 2018; Vörösmarty et al., 2021). Given that MFD relies on Public-Private Partnerships to mobilize capital, we might expect that if a country has had prior experience with PPPs, it would engage more actively with the MFD.

Given that the World Bank uses related macroeconomic and institutional characteristics to gauge a country's 'MFD readiness', I expect that combinations of such conditions will be necessary to promote a country's level of engagement with MFD. Conversely, I expect the lack of a combination of these conditions to inhibit countries from engaging with the Bank's projects.

In addition to these macroeconomic and institutional explanatory variables, it is also necessary to consider variables that have a specific impact on a country's climate-specific public policies. First, it is generally considered that international commitments can rightfully be regarded as important tools for climate governance, given their role in mobilizing domestic action, increasing legislative action, and institutionalizing climate change policy objectives (Christoff & Eckersley, 2011, p. 433; Fankhauser et al., 2016; Harrison & Sundstrom, 2010; Never & Betz, 2014; Röser et al., 2020; Tingley & Tomz,

2020). Secondly, it is suggested that states that face steep economic costs given their propensity for climate-related risks can be expected to be leaders in climate mitigation (Andonova & Sun, 2019; Buys et al., 2009; Dolsak, 2001). As such, I argue that it is plausible that the level of climate risk a country faces will influence its environmental policy and stance towards the World Bank's MFD approach. Finally, the converse reaction can be expected when countries face high costs of mitigation arising from high dependence on fossil fuels (Harrison & Sundstrom, 2010; Mildenberger, 2020; Never & Betz, 2014).

As such, I theorize that higher policy ambitions, higher levels of climate risk and lower fossil fuel dependency can be sufficient (within the necessary contexts) to promote engagement with MFD. Conversely, lower climate ambitions, less climate risk and more dependency on fossil fuels will be sufficient to inhibit the MFD agenda in those countries.

Table 3.2 Variables and Indicators

Variable	Interval-scale Indicator	Variable Type	Source	Period covered
Development level	GDP per capita (current $)	Remote condition	World Bank WDI	2017-2021
Level of debt	Debt to GDP ratio	Remote condition	IMF World Economic Outlook	2017-2021
Governance	Worldwide Governance Indicators	Remote condition	World Bank WGI	2017-2020
Investment climate	Net inflows (% of GDP)	Remote condition	World Bank WDI	2017-2021
Financial development	Index of financial development	Remote condition	IMF IFD	2017-2019
Path dependency	Investment in PPP (% of GDP)	Proximate condition	World Bank PPI Database	2017-2021
International commitments	SDG-NDC links	Proximate condition	World Resources Institute	-
Source dependency	Fossil fuels as energy source	Proximate condition	IEA Energy Balances	2017-2019
Climate risks	Climate Risk Index	Proximate condition	Germanwatch CRI	2000-2019

WDI: World Development Indicators; WGI: Worldwide Governance Indicators; IFD: Index of Financial Development; PPI: Private Participation in Infrastructure database; IEA: International Energy Agency CRI: Climate Risk Index

Table 3.2 lists all the indicators and the data sources used to operationalize the independent variables or conditions as well as the data sources I used. Table 3.3 shows the data for the causal conditions and the outcome for each country. Given that both the academic literature and the World Bank, consider any of these as potential variables that influence a country's climate policy, the expectation is that a combination of conditions,

rather than one condition in isolation, can explain the outcome. Moreover, given the variation of countries under analysis, I expect that different combinations can result in the same outcome for different countries. Thus, the expectation is that engagement with MFD is both context-dependent and equifinal. For these reasons, I will rely on fuzzy-set analysis. In the following section, I elaborate on this methodology and how it helps to address such questions.

3.5 Empirical approach

In this section I use Fuzzy Set Qualitative Comparative Analysis (fsQCA) to examine the contextual variables and climatic variables that affect a country's engagement with private capital mobilization through Maximizing Finance for Development. The goal of fsQCA is to find necessary and sufficient conditions (independent variables) for an outcome (dependent variable) to take place (Schneider & Wagemann, 2012). While statistical approaches seek to identify the net effects of independent variables on a dependent variable while holding all other variables constant, fsQCA aims to identify the complexity behind the interplay of conditions that informs an outcome and, although not without critics, it has quickly established itself in the fields of political science and international studies (Ide & Mello, 2022).

Particularly, fsQCA is well suited for this paper because the number of cases does not allow for a robust multivariable regression analysis and because it allows for equifinality given its assumptions that multiple combinations of conditions (understood as alternate causal paths or 'recipes') may generate the same outcome (Ragin, 2008, p. 54). In contrast to statistical research, fsQCA is built upon Boolean algebra where individual cases are graded with scores that range from 0 (the case is not a member of a set) and 1 (the case is a member of the set). In order to achieve this, fsQCA relies on a process called 'calibration' to translate raw data into a fsQCA scale. Once this step is completed the causal configurations that lead to an outcome are determined using the principles of Boolean algebra in which 'AND' denotes a conjunction of two or more sets, 'OR' denotes a disjunction, and 'NOT' denotes a negation (Ragin, 2008).[12]

[12] Reference on how the process of calibration was carried out can be found in the supplementary online appendix

Table 3.3 Data matrix of the countries and data

	Outcome	Remote conditions						Proximate conditions		
Country	Engagement with MFD *(mfd_eng)*	Economic development *(econ_dev)*	Level of debt *(debt_gdp)*	Governance *(gov)*	Investment climate *(fdi)*	Financial development *(fin_dev)*	Path dependency *(pd)*	International commitments *(int_comm)*	Climate risk *(cl_risk)*	Fossil fuel *(fossil_fuels)*
Argentina	0.27	22849.14	82.90	49.07	1.63	0.32	0.92	3.90	77.00	Net Import
Benin	0.40	3395.58	43.99	17.70	1.40	0.11	0.00	15.58	139.83	Net Import
Burkina Faso	0.68	2244.82	42.17	35.10	0.89	0.12	4.81	11.04	101.00	Net Import
Burundi	0.22	781.06	58.88	28.40	0.08	0.15	0.50	9.09	74.50	Net Import
Cambodia	0.35	4617.07	32.00	17.33	13.30	0.17	5.93	38.96	36.17	Net Import
Cameroon	0.69	3861.47	41.69	26.27	2.10	0.10	5.75	16.23	128.17	Net Export
Ecuador	0.43	11629.53	54.13	28.71	0.99	0.17	1.38	0.00	94.17	Net Export
Egypt	0.83	12350.43	92.58	25.46	2.75	0.29	2.23	27.27	142.17	Net Import
Ethiopia	0.44	2727.66	55.02	41.52	3.45	0.12	0.31	17.53	66.50	Net Import
Ghana	0.21	5688.82	68.35	27.25	4.56	0.15	1.96	11.04	101.33	Net Export
Guinea	0.5	2513.93	40.56	42.18	2.51	0.09	2.80	11.69	159.83	Net Import
India	0.58	6738.19	78.40	29.87	1.81	0.43	1.41	20.78	38.50	Net Import
Madagascar	0.48	1596.05	44.29	23.01	3.52	0.11	2.10	11.69	34.67	Net Import
Mauritania	0.46	6026.68	56.87	20.32	4.92	0.11	4.41	7.14	82.00	Net Import
Mauritius	1.00	22133.31	83.02	36.70	3.12	0.47	0.00	18.18	124.17	Net Import
Myanmar	0.60	4752.25	43.85	61.58	3.82	0.12	3.04	11.69	10.00	Net Export
Nepal	0.68	3953.53	35.52	28.72	0.45	0.19	2.83	21.43	31.33	Net Import
Niger	0.43	1253.60	42.23	24.83	3.71	0.11	0.00	9.09	68.67	Net Import
Papua New Guinea	0.27	3865.42	41.01	27.59	-0.50	0.21	0.00	21.43	90.83	Net Export
Paraguay	0.33	12975.58	28.38	37.47	1.51	0.17	2.15	4.55	67.00	Net Import
Seychelles	0.71	30008.44	66.41	43.36	15.15	0.35	0.00	17.53	160.33	Net Import
Solomon Islands	0.50	2413.27	10.90	64.46	1.79	0.09	15.63	2.60	73.00	Net Import
Tanzania	0.64	2816.94	40.33	46.74	1.64	0.09	0.02	12.34	111.33	Net Export
Thailand	0.29	18516.25	46.51	28.45	1.08	0.71	1.97	14.29	29.00	Net Import
Vietnam	0.71	10388.66	42.64	40.85	6.15	0.38	8.34	33.12	35.67	Net Import
Zambia	0.36	3473.80	101.99	34.82	1.81	0.12	1.87	35.71	111.83	Net Import

Specifically, I employ a two-step version of fsQCA that relies on a distinction between remote and proximate conditions (Schneider, 2019, pp. 1115-1118). Remote conditions are understood as 'the context that influences an outcome'. In contrast, proximate factors are closer to the outcome and, as a consequence, can be said to explain the causal mechanisms of the outcome (Schneider 2019: 1114). This matches well with the previous distinction between MFD readiness conditions and the specific environmental conditions of each country. The first step in this protocol consists of finding whether a condition – or a group of two or more – is necessary for the outcome to occur. This step eliminates all those conditions that are not relevant to explaining the outcome. The second step analyses the remaining conditions and includes the so-called 'proximate conditions' and outputs different solution pathways or 'recipes' that explain the presence of the outcome (Schneider, 2019: 1115-1118).

3.6 Results

The first step identified two contexts that enable engagement with MFD and one which inhibits it. These appear in Table 3.4.

Table 3.4 Identification of context conditions

Outcome	Context	Consistency	Coverage	Relevance
Enable	*fin_dev* OR NOT *debt_gdp*	0.918	0.690	0.645
Enable	*econ_dev* OR NOT *debt_gdp*	0.957	0.660	0.561
Inhibit	NOT *gov* OR *debt_gdp*	0.919	0.657	0.522

Notes: fin_dev = financial development; debt_gdp = level of debt ; econ_dev = economic development ; gov = governance.

Consistency expresses the percentage of cases where the outcome is present, the condition is present or the degree to which an outcome is a subset of a condition. A consistency threshold of 0.9 when evaluating necessity is recommended given that it is as close to 1.0 as a condition will achieve when addressing empirical realities (Ragin 2008; Schneider and Wagemann 2012: 143). On the other hand, the scores for coverage and relevance of necessity measure how trivial or not a condition is. The high coverage (>0.6) and relevance (>0.5) scores for the three contexts indicate that they are not trivial (Schneider, 2019).

These results point to a clear structural selectivity within the MFD framework as engagement with MFD is more common when countries exhibit either financial or economic development, and where debt burdens are manageable. In contrast, countries

with weak governance or high debt-to-GDP ratios are systematically excluded from meaningful participation. This pattern suggests that MFD is effectively calibrated to attract private finance to safer, more stable environments, rather than to the countries most in need of concessional support. Furthermore, the high consistency and non-trivial coverage scores indicate that these context conditions are not incidental but integral to how the blended finance logic operates.

The second step consists of an analysis of sufficiency with the proximate conditions and the remote conditions that result from the analysis of necessity. Thus, conditions fin_dev, econ_dev, and NOTdebt_gdp pass into the analysis sufficiency for the presence of the outcome while ~gov and debt_gdp would pass into the analysis for the absence of the outcome. For added simplicity, one can create new conditions out of them because they are functional equivalents (C = A+B) (Schneider 2019: 1117). In this sense, given that economically and financially developed countries exhibit characteristics akin to highly developed nations in the global north, I create the functional equivalent dev = econ_dev OR fin_dev to express this relationship. On the other hand, because the lack of effective governance and high levels of debt in developing countries have been linked to the 'highly indebted and poor countries' (HIPC) initiative, I create the macro variable hipc = NOTgov OR debt_gdp to express that countries have HIPC-like conditions (and many under consideration are classified as HIPC). The analysis of sufficiency results in the following solution pathways for the outcome (Table 3.5) and its negation (Table 3.6).[13]

Table 3.5 Solution pathways that promote MFD

Causal configuration	InclS	Raw Coverage	Unique Coverage
dev AND int_comm	0.910	0.305	0.123
dev AND NOT cl_risk	0.888	0.299	0.088
NOT debt_gdp AND NOT cl_risk AND NOT fossil_fuels	0.806	0.374	0.217
Overall solution	0.860	0.639	-

Notes: dev = high development; int_comm = strong international commitments; cl_risk = climate risk; fossil_fuels = dependency on fossil fuels

Table 3.6 Solution pathways that inhibit MFD

Causal configuration	InclS	Raw Coverage	Unique Coverage

[13] Analysis of sufficiency yields three solutions: a conservative solution with no simplifying assumptions, an intermediate one which simplifies the solution minimization based on our theoretical expectations, and a parsimonious solution which presents the most important conditions or 'core conditions' which cannot be left out from any solution. For this reason, here I present the parsimonious solution. The other solutions, as well as additional information on how the simplification was carried out, appear in the Online Appendix.

hipc AND cl_risk	0.781	0.744	0.593
hipc AND fossil_fuels	0.829	0.159	0.009
Overall solution	0.758	0.752	-

Notes: hipc = HIPC-like contex; int_comm = strong international commitments; cl_risk = climate risk; fossil_fuels = dependency on fossil fuels.

Solution pathways in fsQCA are assessed through consistency scores and coverage scores. The first indicates how each solution is in line with the empirical evidence, and it has been suggested that it is a similar – but not identical – measure to that of significance values in statistical research. The consistency scores of all the solution pathways presented are well above the 0.75 threshold that is suggested in the literature. The second indicates how much of the outcome is explained by the solution; in this case, there is no threshold for coverage given that solutions that explain a small amount of the outcome can be significant such as having a small but significant R^2 in statistical research (Ide and Mello 2022; Ragin 2008: 46; Schneider and Wagemann 2012: 232-234). In this sense, the high consistency and coverage scores for all the solution pathways are significant and indicate that they are strongly consistent and cover a large number of cases.

These solutions pathways further illuminate the selective logic of financial engagement under the MFD paradigm. Countries exhibiting both high development and either strong international commitments or low climate risk appear to be consistently included in MFD pipelines. This confirms that MFD operates not only through macroeconomic filters (such as debt sustainability) but also through environmental signaling and technical risk assessments. Interestingly, the solution combining low debt, low climate risk, and low fossil fuel dependency suggests that private finance favors contexts where both economic and environmental uncertainties are minimized.

The results show that despite the World Bank to resolve the paradox between being a development agency and a bank, multilateral development banks (MDBs) and blended finance initiatives, while designed to mobilize private capital for the Global South, disproportionately benefit countries that are already fiscally stable, institutionally strong, and financially integrated. This bias towards richer, less vulnerable countries suggests that concessional finance mechanisms are constrained by the risk frameworks of private partners, who prioritize creditworthiness over climate vulnerability. As a result, countries with the greatest need for adaptation finance (often those most vulnerable to climate and credit shocks) are excluded from the private capital mobilization narrative. These findings resonate with critiques that blended finance may exacerbate rather than alleviate global

inequalities unless explicitly redesigned to reward risk-taking in fragile contexts. Furthermore, the MDBs' reliance on intermediary financial institutions and de-risking instruments has created a landscape where local ownership and developmental impact risk being sidelined. A more inclusive model would involve differentiated instruments and metrics that reward equity, justice, and transformational impact, not just risk-adjusted return.

3.7 Discussion

Analysis for necessity revealed two contexts that foster engagement for maximizing finance for climate-aligned development. This finding reveals that financially or economically developed countries that have low levels of debt will be more prone to engage with this development initiative. My findings are consistent with scholarship that underlines the structural power that finance plays in constraining the policy space of developing economies (Hardie, 2012; Jafri, 2019; Musthaq, 2021) given that well-developed financial markets (*fin_dev*) and fiscal discipline (*NOT debt_gdp*) are necessary to enable this rollout of private capital. Given that, as I mentioned MFD relies on complex financial instruments that countries with less developed financial sectors might lack the capacity to work with (such as blended finance and PPP) to mobilize finance, there is a burden on governments to create favorable conditions for investable long-term assets (Inderset, 2021). Theoretically, less developed countries could be pushed to further liberalize their financial sectors and to limit public expenditure so as not to be denied vital sources of funding. More importantly, it shows that MFD is flowing towards countries with higher incomes as they are more profitable for investors.

Analysis of necessity also revealed that countries lacking good governance or having high levels of debt are not fertile ground for the MFD initiative. This finding challenges the adequacy of MFD given that it appears it is not targeting the countries it was originally intended to help. Since its inception in the 'Forward look' document, a special emphasis has been placed on using private capital mobilization to aid in the development of IDA countries affected by fragility, conflict, and violence (World Bank, 2017a, p. 3). This suggests that MFD is not reaching those it intended to help.

My findings are, therefore, consistent with criticisms that blended finance instruments have a middle-income bias given the lack of interest that low-income and fragile countries

generate in institutional investors (Bayliss et al., 2020). Moreover, findings are aligned with critics who claim that the PSW is not living up to expectations. Critics point out that the PSW only committed about a fifth of the resources at its disposal six months before the entire PSW was scheduled to be allocated and that during the IDA replenishing window, its resources were not increased, which reflected donor unwillingness to invest in this approach (Dimakou et al., 2021, pp. 224-225). Taken together these findings confirm that the Bank's MFD initiative is biased toward higher-income and more stable countries that might not have the same issues accessing capital markets as do those on the lower end of the income and governance spectrum. This implies that by focusing its operations on the MFD initiative the Bank is again tilting toward its bank-like activities.

Additionally, these findings are problematic because they that the principle of 'common but differentiated responsibilities' or CBDR – a compromise between developed and developing states of who ought to 'take the lead' in reducing emissions and over questions of who ought to finance it is further being eroded.

The CBDR principle has long been assumed to be one of the underlying tenets of the climate regime since its recognition by the United Nations Framework Convention for Climate Change in 1992. This principle was instrumental in fostering global cooperation and catalyzing political negotiations by providing the basis on which the particular situation of countries in the global South was to be taken into account. However its relevance has been criticized given that developed countries never internalized it due to their dislike of the 'differentiated responsibilities' part and as such, have failed to effectively structure the climate regime (Kolmaš, 2023; Kolmaš & Kolmašová, 2023). Under MFD the responsibility lies not on developed countries to ´pay up' but, firstly on developing countries to liberalize financial sectors, improve the investment climate, and promote sound and sustainable financing practices to attract private capital to fund their climate commitments, and secondly on the private sector to provide the financial support. (World Bank, 2017b, p. 2). How much further this strategy erodes this principle is still to be theorized and studied empirically.

Focusing now on the second step of the analysis, it shows three solution pathways or recipes for promoting engagement with MFD and two that inhibit it. Interestingly, the third and the second solution pathways show that the necessary contexts that foster engagement with MFD must be combined with low levels of climate risk (Table 5). This

result is supported by the first solution pathway in Table 6 that shows that countries with high risks of climate disasters have lower levels of engagement with MFD. In addition to this, two pathways that promote engagement with MFD and a pathway that inhibits MFD paint a complementary picture as how fossil fuels play a crucial role given that countries that do not rely on fossil fuels are more likely to engage in the Banks' strategy while countries that do depend on fossil fuels will show less engagement with it. As such, my findings suggest that MFD is inefficient in helping fossil fuel dependent economies transition to greener sources of energy.

These findings suggest that, despite the presence of the Bank's risk-sharing instruments, investors are still wary of potential green swans (Bolton et al., 2020) and are reluctant to invest in countries with high levels of climate risk. In the case of Zambia, for instance, it is estimated that every $1 of concessional finance mobilized only 28 cents of private financing (Emery, 2023). This is relevant because research has shown that the World Bank and other MDBs are incredibly effective when directing their aid to the poorest countries (Briggs, 2017; Briggs, 2021) and those that are more at risk of climate disasters (Eisenstadt et al., 2021). This effectiveness was showcased when the World Bank and other MDBs had to pick up the pace so that low-income countries did not starve of funds when, in recent years, financial flows those countries slowed down (Figure 2).

However, this efficiency is related to the Bank's role as a lender of public finance in contrast to this new role of mobilizer of private finance and, as such, it suggests that public financing is more adept at funding climate change adaptation projects than private finance as it is better at targeting the countries that need mitigation and adaptation finance the most. On the other hand, my findings show that MFD has a middle-income bias given the lack of interest that low-income and fragile countries generate in institutional investors. This bias toward wealthier countries, however, is not due to institutional design given that, as I mentioned previously, as a corporate strategy *Maximizing for Development* encompasses all of the World Bank's institutions and so was designed to prioritize the mobilization of private capital even in the less developed countries (World Bank, 2017a, p. 3; 2017c, p. 43). Moreover, given that cases were selected because the World Bank's diagnostic documents for such countries had an explicit intention of implementing MFD in them, this implies that this strategy is not targeting many of the countries it was designed to help.

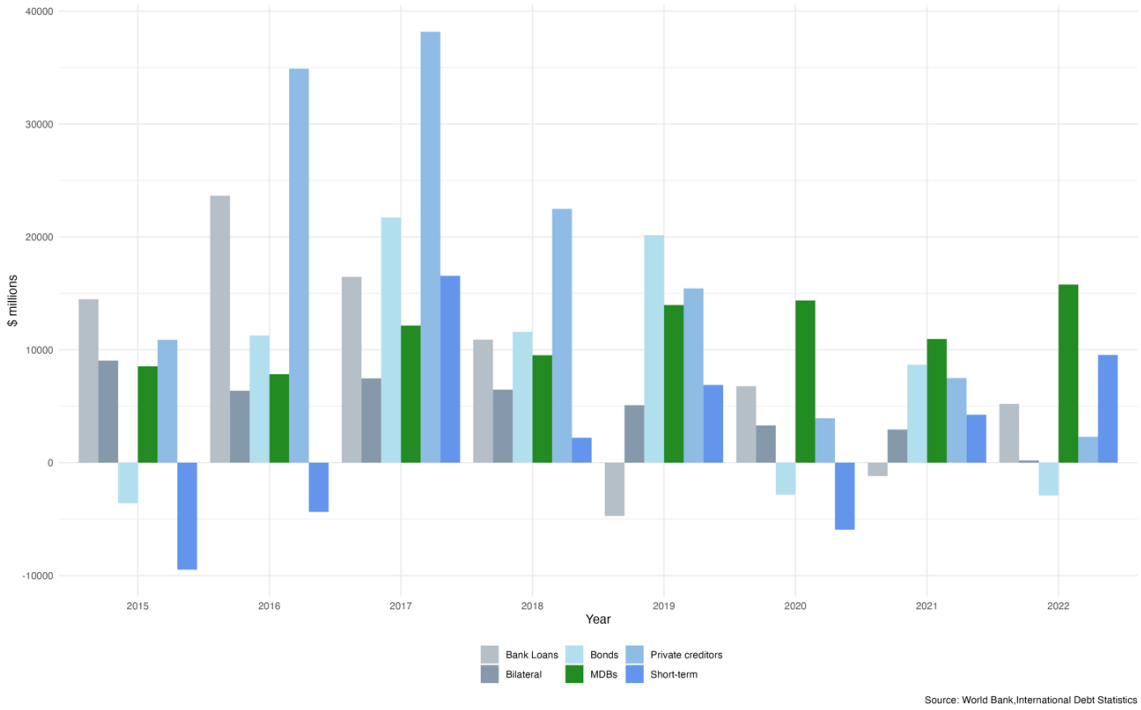

Figure 3.2 Sub-Saharan Africa: Net Debt Inflows

Taken together, these solutions display the *cakeism* behind the Bank's Maximizing Finance for Development to resolve its institutional tension but reveals them to still tilts towards its bank-like aspect. Equally, it shows the limits of the derisking state given that public funds used to subsidize private finance are not enough to provide adequate investment opportunities for financiers.

3.8 Conclusions

Through this paper, I have argued that the new corporate strategy of the World Bank tries to resolve the tension between bank and developing agency. The Maximizing Finance for Development agenda emphasizes the possibility of identifying projects that address climate vulnerability and offer a sufficiently attractive balance of risk and reward to generate private financial flows to support implementation. However, I have found that the Bank, through this MFD agenda, fails to effectively deliver. From MFD, we see another instance of the World Bank prioritizing its bank-like activities by acting as a mobilizer of finance in a way that does not prioritize the development needs of the most vulnerable. I have demonstrated here that this shift is problematic because there are strong limits to the mobilization capacity of the Bank, given that its Risk-sharing instruments seem insufficient to incentivize private investment in the countries that most need adaptation and mitigation finance. Crucially, the MFD-related dynamics I uncover

here contrast with the Bank's previous public finance-based operations that were demonstrated to be highly effective in directing aid to the poorest and more at-risk countries (Briggs 2017; Eisenstadt et al 2021). This suggests that public financing is more adept at funding climate change adaptation projects than private finance, as these types of higher-risk climate change projects are more likely to be supported when there is no need to 'turn a profit'.

Given this lack of interest of the private sector in investing in poor and at risk countries and how crucial concessional finance from the World Bank and other Multilateral Development Institutions is for developing countries (Figure 2), in order to achieve its twin goals of ending extreme poverty and promote shared prosperity in a sustainable way it makes sense for the Bank to retraces its steps from being a mobilizer of private finance to a lender of concessional finance as well as increasing its focus in debt relief strategies such as the HIPC initiative not out of generosity but in response of the ecological debt that also exists.

Moreover, I have also contributed empirically to the comparative literature on variation in climate policy by analyzing developing countries, which have been generally overlooked. and finding patterns that explain variations in the use of PCM for climate aligned development. Finally, I have contributed to the literature on the relationship between the Bank and its borrowing countries by going beyond explanations that rely on the presence of 'sympathetic interlocutors' as drivers of country engagement with the Bank, and have highlighted the characteristics that the Bank considers for gauging a country's 'MFD readiness' are necessary (i.e. either financial or economic development and lack of debt) and which conditions discourage the use of PCM for climate-aligned development (lack of governance and high levels of debt).

My findings raise but do not solve important questions, thereby indicating several areas for future research. For instance, it is not clear precisely how Maximizing Finance for Development shapes the incentives for financiers to engage with it or to change their investment strategies, so studies taking a complementary focus on these institutions are needed. Moreover, it has been suggested that blended finance instruments can relocate funds from sectors in need into the hands of private shareholders incentivizing 'tied-aid', which often prevents recipient countries from benefiting completely from such

instruments (Oxfam, 2017). As such, there is scope for further research analyzing the nature of financial flows.

Appendix 3.A Data Sources and calibration

Fuzzy sets allow us to address the degree of membership and partial membership in sets by assigning values in the interval between 0.0 (nonmembership) and 1.0 (full membership) to cases. This is done by *calibrating* continuous or categorical variables into scales that indicate degree membership. First by specifying three qualitative anchors: full membership, full nonmembership, and the crossover point (the point of the value of the interval scale variable where there is maximum ambiguity as to whether a case is more in or more out of the target set); and secondly by calibrating degree membership in the target set by transforming the interval-scale variables into the log odds metric (Ragin, 2008, pp. 88-90). Here I explain the process of calibrating the outcome and conditions.

Outcome.

The raw scores as seen in Table 1 for engagement with MFD ranged from 21% in Ghana to 100% in Mauritius. As no country had engagement less than 20%, the exclusion threshold was set at 19% so that all of the countries considered showed different degrees of set membership in the outcome. On the other hand, the inclusion threshold was set at 100% to reflect that countries which exclusively mobilize private capital to fund their climate change mitigation and adaptation development needs happen empirically. Finally, the crossover point was set as the median at 47%. High level of engagement with MFD is coded as 1 while low levels as 0. The states' scores were then calibrated along a continuous scale between these three thresholds.

Table A 3.1Engagement with MFD Scores

Country	Raw data	fsQCA Score
Argentina	0.27	0.111
Benin	0.40	0.323
Burkina Faso	0.68	0.762
Burundi	0.22	0.069
Cambodia	0.35	0.22
Cameroon	0.69	0.77
Ecuador	0.43	0.391
Egypt	0.83	0.88
Ethiopia	0.44	0.41
Ghana	0.21	0.06
Guinea	0.5	0.541
India	0.58	0.652
Madagascar	0.48	0.513
Mauritania	0.46	0.476
Mauritius	1.00	0.95
Myanmar	0.60	0.672
Nepal	0.68	0.761
Niger	0.43	0.407
Papua New Guinea	0.27	0.111
Paraguay	0.33	0.191
Seychelles	0.71	0.795
Solomon Islands	0.50	0.541
Tanzania	0.64	0.723
Thailand	0.29	0.126
Vietnam	0.71	0.791
Zambia	0.36	0.245

Economic Development

The role of economic development as a factor driving economic policy has been linked to the concepts of environmental Kuznets curve (Grossman & Krueger, 1995) and ecological modernization (Mol & Sonnenfeld, 2000) given the idea that wealthier countries have greater means to reduce emissions. For instance, Tobin (2017) finds that a high GDP per capita is a necessary component to explaining ambitious climate policy in OECD countries. Liefferink et al. (2009)find that economic development is conducive to strong environmental outputs, although they consider it of secondary importance. In contrast, Börzel (2002)sees economic development as the single most important factor in determining the strength of environmental policy. Lamb and Minx (2020)find that wealthy countries are the least constrained when formulating climate policies and it has also been suggested that higher available resources are also correlated to higher levels of funding for adaptation to climate change(Lesnikowski et al., 2013; Massey et al., 2014).

To score economic development, I extracted GDP per capita in current international dollars PPP from the World Development Indicators database of the World Bank corresponding to data from 2017 to 2021 and estimated the average to find a value for the period. I relied on the World Bank's country classifications by income. According to this classification, the countries under analysis fall under (i) low-income economies, (ii) lower-middle-income economies, and (iii) upper-middle-income economies.

I then estimated the median per capita GDP of countries in the lower-middle-income classification to establish a crossover threshold of $4285.30. Burundi with a per capita GDP of $781 was set as the exclusion threshold and Argentina was coded as the inclusion threshold (I excluded Seychelles given it is classified as a high-income economy). Economic development is coded as 1, and not economic development is 0. The states' scores were then calibrated along a continuous scale between these three thresholds.

Table A 3.2 Economic Development Scores

Country	Year					fsQCA Score
	2017	2018	2019	2020	2021	
Argentina	23,597.12	23,290.64	22,997.40	20,763.82	23,596.73	0.955
Benin	3,044.52	3,234.84	3,422.43	3,498.60	3,777.53	0.321
Burkina Faso	2,044.39	2,170.98	2,270.26	2,275.78	2,462.69	0.153
Burundi	770.707	778.468	783.49	772.416	800.198	0.05
Cambodia	4,101.00	4,467.44	4,833.97	4,715.50	4,967.44	0.514
Cameroon	3,665.12	3,801.24	3,901.73	3,869.73	4,069.53	0.412
Ecuador	11,623.7	11,880.3	11,923.0	10,972.8	11,747.78	0.77
Egypt	11,158.2	11,796.5	12,444.1	12,823.3	13,529.93	0.79
Ethiopia	2,321.44	2,519.66	2,752.47	2,907.85	3,136.89	0.213
Ghana	5,148.05	5,481.37	5,821.65	5,798.89	6,194.17	0.557
Guinea	2,249.56	2,390.00	2,507.43	2,633.64	2,789.04	0.184
India	6,182.92	6,669.61	6,965.53	6,531.97	7,340.90	0.599
Madagascar	1,586.40	1,613.02	1,652.05	1,498.17	1,630.61	0.094
Mauritania	5,636.44	5,898.12	6,212.99	6,044.53	6,341.33	0.571
Mauritius	21,415.3	22,733.7	23,816.0	20,506.0	22,195.36	0.949
Myanmar	4,332.72	4,684.39	5,053.19	5,240.84	4,450.10	0.519
Nepal	3,565.20	3,863.86	4,119.59	4,008.17	4,210.81	0.431
Niger	1,163.64	1,229.44	1,276.01	1,288.64	1,310.29	0.073
Papua New Guinea	3,809.4	3,810.10	3,969.25	3,796.87	3,941.44	0.413
Paraguay	12,433.7	12,953.6	12,949.3	12,818.7	13,722.38	0.807
Seychelles	28,530.6	29,816.8	30,991.4	28,703.5	31,999.80	0.986
Solomon Islands	2,381.01	2,468.74	2,478.76	2,348.59	2,389.26	0.172
Tanzania	2,527.81	2,687.04	2,840.42	2,925.62	3,103.81	0.225
Thailand	17,422.9	18,533.9	19,216.8	18,197.9	19,209.59	0.912
Vietnam	9,085.61	9,867.43	10,559.3	10,897.0	11,533.88	0.732
Zambia	3,407.31	3,520.21	3,526.11	3,366.14	3,549.22	0.336

Level of Debt

To test the level of indebtedness a country has in order to determine its relevance for the levels of engagement or non-engagement with MFD each country exhibits, I relied on the IMF's *World Economic Outlook* database and extracted the relevant data from the years 2017 to 2021, the year with latest available data. I then averaged them to estimate a single score for the period. The thresholds for inclusion, exclusion and the crossover point were determined theoretically based on the way the IMF classifies central government debt. The inclusion threshold for highly indebted countries was set at 100% of debt-to-GDP ratio, the exclusion threshold for countries with low levels of debt was set at 25% and finally, the crossover point was set for countries whose debt-to-GDP ratio was 50% based on both of the IMF's classification and on hierarchical cluster analysis using Euclidean distance. The presence of high levels of debt is coded as 1, whilst the absence of low levels of debt is coded as 0. The states' scores were then calibrated along a continuous scale between these three thresholds.

Table A 3.3 Level of Debt Scores

Country	Year						fsQCA Score
	2017	2018	2019	2020	2021	2022	
Argentina	57.028	85.246	88.835	102.79	80.617	74.431	0.874
Benin	39.598	41.08	42.523	46.142	50.617	49.292	0.330
Burkina Faso	33.648	37.979	42.017	46.541	50.664	53.39	0.285
Burundi	46.902	52.971	59.988	65.965	68.592	69.168	0.628
Cambodia	29.969	28.458	28.588	34.267	38.729	40.861	0.107
Cameroon	36.539	38.335	41.597	44.852	47.143	45.158	0.273
Ecuador	47.03	49.087	51.411	60.89	62.237	54.131	0.561
Egypt	103.04	92.484	84.214	89.647	93.498	93.984	0.925
Ethiopia	55.278	58.449	54.699	53.697	52.95	48.32	0.573
Ghana	56.984	61.976	62.694	78.303	81.806	84.571	0.747
Guinea	41.884	39.267	38.373	44.027	39.262	39.077	0.248
India	69.677	70.392	75.105	90.056	86.758	86.902	0.842
Madagascar	40.136	40.393	38.522	49.005	53.387	57.932	0.338
Mauritania	54.761	58.856	56.831	59.192	54.722	55.492	0.600
Mauritius	64.335	66.223	84.621	99.184	100.712	98.853	0.875
Myanmar	38.47	40.415	38.753	39.276	62.343	58.825	0.326
Nepal	24.989	30.081	33.134	42.159	47.236	51.505	0.154
Niger	36.494	36.907	39.802	44.981	52.947	53.754	0.286
Papua New Guinea	32.484	36.676	40.166	46.442	49.298	45.168	0.258
Paraguay	19.847	22.331	25.78	36.899	37.017	39.39	0.073
Seychelles	60.339	55.91	54.205	89.097	72.511	76.691	0.724
Solomon Islands	8.386	8.3	8.197	13.119	16.473	22.49	0.010
Tanzania	40.732	40.544	39.036	40.528	40.792	39.815	0.242
Thailand	41.778	41.941	41.058	49.752	58.04	62.682	0.399
Vietnam	46.32	43.712	41.292	41.668	40.182	41.261	0.296
Zambia	66.317	80.517	99.734	140.211	123.172	101.9902	0.955

Governance

States can take a variety of roles in influencing sustainable transitions either as an enabler or as a barrier (Johnstone & Newell, 2018) and so the institutional makeup of states has been widely studied when comparing climate policies. In advanced capitalist democracies, it has been shown that corporatist market economies tend to perform better than liberal market economies(Farstad, 2019; Lachapelle & Paterson, 2013; Liefferink et al., 2009). Moreover, how different party systems are structured can influence how climate policy is addressed (Carter & Little, 2021; Harrison & Sundstrom, 2010; Ozymy & Rey, 2013) and that federal states tend to lag behind unitary states due to the presence of more veto points in policy making (Lachapelle & Paterson, 2013; Tobin, 2017) although – perhaps paradoxically - being a member of the European Union is seen as one of the most decisive positive factors in explaining climate policy ambition (Liefferink et al., 2009; Schmidt & Fleig, 2018; Tobin, 2017) To score governance effectiveness I rely on the World Bank's *Worldwide Governance Indicators* (WGI); a set of indicators that measure the degree in each country of (i) accountability, (ii) political stability and absence of violence, (iii) the effectiveness of government, (iv) the regulatory quality, (v) the rule of law, and (vi) corruption.

To score the condition of governance I aggregated the six scores into one with data from 2017 to 2020 and then averaged the scores to find a value for the corresponding period. After this, I conducted a cluster analysis of the distribution to establish the crossover points at a score of, 39.15569. For inclusion and exclusion, the scores of the Solomon Islands (highest) and Cambodia (lowest) were selected. The presence of effective governance is coded as 1, whilst non-effective governance is coded as 0. The states' scores were then calibrated along a continuous scale between these three thresholds.

Table A 3.4 Governance Effectiveness Scores

Country	Year				fsQCA score
	2017	2018	2019	2020	
Argentina	51.9358921	51.5837644	47.1071676	45.6501293	0.76
Benin	17.5337087	16.2871259	19.2521108	17.7272792	0.052
Burkina Faso	36.4159406	37.2422765	32.2852254	34.4592692	0.366
Burundi	30.1286782	29.0488514	26.2632441	28.1768991	0.189
Cambodia	15.6683141	14.1663178	20.0621937	19.429815	0.05
Cameroon	27.0978586	29.844306	24.2659183	23.8618673	0.149
Ecuador	22.875326	23.76922	34.6884794	33.5005143	0.196
Egypt	25.7926246	28.8485416	23.2845796	23.9282423	0.136
Ethiopia	44.5892274	44.7394315	38.3606094	38.3765028	0.568
Ghana	23.9520173	23.9588367	31.1340545	29.9336433	0.166
Guinea	41.0183779	42.0424681	42.0288614	43.6124722	0.587
India	31.4840954	32.6510712	27.5455077	27.7926405	0.221
Madagascar	23.4032515	22.1429048	23.0768797	23.4140223	0.101
Mauritania	19.7868778	19.5339653	21.0118197	20.9498339	0.072
Mauritius	33.0268205	30.9894142	42.1249841	40.6709331	0.418
Myanmar	67.352059	66.913537	55.432526	56.6363106	0.932
Nepal	25.9423812	26.4453238	29.8273395	32.6730696	0.196
Niger	25.9744059	26.3820308	22.9905575	23.9653885	0.126
Papua New Guinea	27.1753292	28.0136852	27.1326621	28.0174103	0.173
Paraguay	33.9978317	38.9205421	37.9518321	38.9905113	0.443
Seychelles	41.7947925	41.4435476	44.0557159	46.135711	0.62
Solomon Islands	63.9937789	64.2583644	64.0360864	65.5407683	0.95
Tanzania	46.9163138	45.6393115	47.6001488	46.7927834	0.707
Thailand	30.1695716	27.8974622	27.6526152	28.0672868	0.19
Vietnam	40.2581739	40.0721954	40.399953	42.6545132	0.549
Zambia	37.8024871	37.2047218	33.5452998	30.7396514	0.357

Investment Climate

Institutional investors such as sovereign wealth funds, insurance company resources, and asset managers are at the core of MFD given that the World Bank considers them the most important sources of financing for emerging markets for investment in large infrastructure and energy projects(World Bank, 2015). However, most institutional investors have a lower boundary for the risk they can assume in their investments and will choose their portfolio accordingly (Afonso et al., 2007) and for most emerging market economies meeting this lower boundary for investment-grade rating required by most institutional investors can often be a challenge. This factor implies that a country with a more hospitable investment climate can mobilize more capital, while a country perceived as credit risk will need to tackle these challenges first through policy reform in line with the 'cascade approach'. As such, countries that have an attractive investment climate are expected to have higher engagement with MFD.

To operationalize this variable, I relied on the foreign direct investment expressed as net inflows as a percentage of GDP that I extracted from the World Development Indicators database of the World Bank from 2017 to 2020 (the year with latest available data) and then averaged them to find an estimate a score for the entirety of the timeframe. To set the exclusion and inclusion thresholds I excluded Papua New Guinea which reported negative inflows during the period as well as Cambodia and Seychelles whose net inflows were substantially larger than the rest of the countries so as not to skew the distribution. Burundi and Vietnam were set as the lower and upper limit thresholds. For the crossover point, I conducted a cluster analysis and established it as equivalent of a percentage of GDP of 2.303828. The presence of good investment climate is coded as 1, while not good investment climate is coded as 0. The states' scores were then calibrated along a continuous scale between these three thresholds.

Table A 3.5 Investment Climate Scores

Country	Year				fsQCA score
	2017	2018	2019	2020	
Argentina	1.78936428	2.23253221	1.47434943	1.03241088	0.290
Benin	1.58170509	1.36073584	1.51620778	1.12361921	0.229
Burkina Faso	0.01823703	1.68919956	1.00734645	0.82836504	0.131
Burundi	0.01151574	0.03686523	0.03971062	0.21314376	0.048
Cambodia	12.5718497	13.0744981	13.5220211	14.0443511	1.000
Cameroon	2.25620956	1.91398182	2.58319635	1.65468962	0.433
Ecuador	0.60358331	1.2908431	0.90087266	1.16411807	0.147
Egypt	3.14282605	3.26026279	2.97283696	1.60212389	0.587
Ethiopia	4.91270718	3.98771254	2.65736063	2.22564789	0.713
Ghana	5.38848685	4.44140705	5.67745282	2.73707938	0.858
Guinea	5.59427175	2.97511257	0.32855281	1.12460575	0.54
India	1.50731658	1.55926352	1.76312751	2.41941471	0.341
Madagascar	3.52797151	4.44792805	3.36279835	2.74559548	0.725
Mauritania	8.65142918	10.5091825	-11.198972	11.7254708	0.889
Mauritius	3.62005558	3.24716512	3.35631866	2.25208233	0.657
Myanmar	7.81825879	2.63340939	2.52641334	2.29701314	0.77
Nepal	0.67743988	0.2061572	0.54280198	0.3762239	0.078
Niger	3.02823075	3.63849344	5.55220167	2.62458076	0.754
Papua New Guinea	0.7099915	4.7062074	-3.6388148	-3.7921982	0.023
Paraguay	1.90942198	0.8187996	1.57289966	1.74560274	0.258
Seychelles	8.14436022	19.8789488	16.0395485	16.5215944	1.000
Solomon Islands	2.89022532	1.58723196	2.08822585	0.58089878	0.334
Tanzania	1.75860651	1.70440977	1.99100016	1.09740566	0.291
Thailand	1.81550201	2.60285045	0.88015441	-0.9658965	0.164
Vietnam	6.30083495	6.32101749	6.15452176	5.82685158	0.955
Zambia	4.28050117	1.55231397	2.35091904	-0.9538752	0.34

Financial Development

The importance of a developed financial sector climate-aligned development has been documented in the literature such as in energy(Ng & Tao, 2016; Tian, 2018), building a climate-resilient economy(Louche et al., 2019), and promoting climate change mitigation policies(Bachner et al., 2019; Sweerts et al., 2019). Moreover, the Bank and sophisticated institutional investors prefer to use complex financial instruments that emerging and developing countries with under-developed financial sectors might lack the capacity to work with(IEG, 2020, p. 73; World Bank, pp. 25,76). In this sense, countries with relatively developed financial sectors can issue project bonds or structure securitized instruments that meet the need of institutional investors for investment-grade instruments, while countries with less developed financial sectors might need to rely on other structures such as funds(Inderset & Stewart, 2014, p. 10). Thus, I expect a more financially developed country to have higher engagement with MFD.

Using data from the Index of Financial Development of the IMF, I extracted the scores for financial development from the period between 2017 and 2019 (the year with the latest available data) and averaged them. The inclusion threshold was set using advanced economies as a reference given that, theoretically, the more advanced an economy is, the more developed its financial sector will be. As such, I used the score of 0.57 which is the mean score of financial development of advanced economies as the inclusion threshold. Conversely, given that low-income countries are expected to have less developed financial sectors, I use the mean score of low-income countries (0.10) as the exclusion threshold. Finally, for the crossover point, I rely on the mean score of emerging economies (0.23) as we can expect such economies to be on the border between financial development and underdevelopment. Financial development is coded as 1 and non-financial development is coded as 0. The states' scores were then calibrated along a continuous scale between these three thresholds.

Table A 3.6 Financial Development Scores

Country	Year			fsQCA Score
	2017	2018	2019	
Argentina	0.33344752	0.31794795	0.31246585	0.688
Benin	0.09807833	0.10527342	0.12341285	0.060
Burkina Faso	0.11472362	0.11718804	0.11345173	0.069
Burundi	0.13506913	0.14355019	0.16264679	0.133
Cambodia	0.15669689	0.16254181	0.18066096	0.192
Cameroon	0.09220921	0.08257572	0.10989483	0.045
Ecuador	0.15978114	0.16845314	0.17222479	0.193
Egypt	0.28689072	0.28819048	0.29941818	0.630
Ethiopia	0.11295328	0.11800208	0.11724895	0.070
Ghana	0.14566681	0.14389583	0.15305713	0.134
Guinea	0.09100568	0.07876585	0.08409083	0.036
India	0.43572223	0.43647963	0.42983112	0.854
Madagascar	0.10422309	0.10438026	0.10620584	0.056
Mauritania	0.11057372	0.1039986	0.10696147	0.058
Mauritius	0.47879219	0.41566238	0.49958524	0.884
Myanmar	0.11642063	0.12125912	0.12220424	0.076
Nepal	0.17566273	0.19127384	0.19893438	0.281
Niger	0.1127999	0.11499456	0.11428273	0.067
Papua New Guinea	0.2089593	0.20985642	0.21003884	0.386
Paraguay	0.16907667	0.17220058	0.17750256	0.215
Seychelles	0.3487756	0.34959301	0.35614896	0.741
Solomon Islands	0.08666084	0.08640472	0.08640472	0.037
Tanzania	0.09385154	0.09461375	0.0901922	0.043
Thailand	0.70104891	0.72150135	0.70044708	0.984
Vietnam	0.38604057	0.39446372	0.35770905	0.785
Zambia	0.12138719	0.11811777	0.12003141	0.076

Path Dependency

Path dependency posits that institutions are difficult to because they 'generate powerful inducements that reinforce their own stability and further development'(North, 1990; Pierson, 2000, p. 255). In both development and environmental studies, this concept of path dependency has been widely used in research in order to show how it conditions the range of options available(Aklin & Urpelainen, 2013; Harvey & Pilgrim, 2013; Kirk et al., 2007). In the case of infrastructure development this dependency can be even more important given that formulating a good infrastructure policy has been characterized as being as a 'wicked problem' that policy-makers find hard to resolve (Docherty, 2013) and so we can expect that if states are implementing certain infrastructure policies, they will be more open to do so again in the future. More narrowly, path dependence has also been used to explain the implementation or lack thereof of sustainable infrastructure(Steen & Hansen, 2018; Vörösmarty et al., 2021). Focusing on Public-Private Partnerships (PPPs) – given its centrality in the Bank's PCM strategy – we might expect that if a country has had prior experience with PPPs, it would engage more actively with the MFD.

To operationalize this condition, I will focus on Public-Private Partnership. To score this condition, I extracted the investment of private participation in infrastructure from the years 2017 to 2021 and aggregated them to calculate the total PPI Investment for the period. The PPI database records investment in infrastructure projects with private participation, not private investments alone so it serves as a proxy for the prevalence of PPP in countries. In addition to this, I estimated the average GDP in constant $ (reference year 2015) for the same period in order to calculate the total PPI investment as a percentage of GDP to make the numbers comparable among each country. In this case, there is no theoretical information about what a "high path dependency" in PPP means, I take a data driven approach to calibrate this variable. This was done carefully given that five countries had non-existent investment in PPPs during the period. Thus, the exclusion threshold was set on the lowest non-zero country which was Tanzania. On the other end of the distribution, the Solomon Islands reported almost double of the next country and so, as to not skew the calibration, I considered Vietnam as the threshold for inclusion. Cluster analysis set the threshold for the crossover point at 3.606069. High levels of path dependency are coded as 1.00 and low levels as 0.00. The states' scores were then calibrated along a continuous scale between these three thresholds.

Table A 3.7 Path Dependency Scores

Country	Total PPP Investment 2017-2021 (Billion USD)	Average GDP (Billion USD)	% of GDP	fsQCA Score
Argentina	5198.32	566996.48	0.92	0.099
Benin	0.00	13652.53	0.00	0.049
Burkina Faso	694.53	14450.48	4.81	0.68
Burundi	15.70	3170.06	0.50	0.072
Cambodia	1328.91	22404.65	5.93	0.811
Cameroon	2104.15	36573.70	5.75	0.794
Ecuador	1374.89	99401.88	1.38	0.139
Egypt	8615.38	386354.27	2.23	0.244
Ethiopia	271.00	86218.23	0.31	0.063
Ghana	1172.00	59766.06	1.96	0.206
Guinea	330.50	11796.04	2.80	0.341
India	36017.71	2554664.42	1.41	0.142
Madagascar	264.10	12574.68	2.10	0.225
Mauritania	310.00	7028.92	4.41	0.624
Mauritius	0.00	12654.84	0.00	0.049
Myanmar	2449.60	80525.26	3.04	0.386
Nepal	819.70	28982.30	2.83	0.346
Niger	0.00	11785.15	0.00	0.049
Papua New Guinea	0.00	23990.09	0.00	0.049
Paraguay	868.00	40384.45	2.15	0.232
Seychelles	0.00	1495.94	0.00	0.049
Solomon Islands	233.37	1493.56	15.63	0.999
Tanzania	9.70	58230.25	0.02	0.05
Thailand	8730.73	444090.23	1.97	0.207
Vietnam	20084.98	240919.68	8.34	0.951
Zambia	440.00	23520.76	1.87	0.194

International commitments

Variables that cluster around a theme of 'policy aspirations' are also commonly used to measure the strength of environmental policy(Christoff & Eckersley, 2011, p. 433). In this sense, international commitments can be regarded as important tools for climate governance given that they can play a critical role in mobilizing domestic action(Harrison & Sundstrom, 2010). For instance, they can help shape domestic public support for environmental policies (Tingley & Tomz, 2020) and can be a source of performance legitimacy. Additionally, they have led to an increase in climate-related legislative activity, and so they influence domestic policy through binding obligations in international law(Bernstein & Cashore, 2012; Fankhauser et al., 2016); and also can effectively act as drivers that institutionalize climate change policy objectives(Röser et al., 2020).

To operationalize policy ambitions in the international arena, I looked at both the Sustainable Development Goals (SDGs) and the intended nationally determined contributions from the Paris Agreement, arguably the two most important global governance initiatives from the past 10 years. There is growing recognition of the strong connections between the two agendas which were adopted only three months apart in 2015. Here it is important to focus both on climate commitments and on Sustainable Development Goals for two main reasons: the specific intention of the World Bank when announcing its Maximizing Finance for Development corporate strategy and the specific context in which developing countries address climate change.

First, the World Bank argued that a paradigm shift in how development aid was disbursed to developing countries was needed in order to unlock the resources needed to achieve the SDGs and, as such, proposed MFD to fill this funding gap (World Bank, 2017). In addition to this, the World Bank sees development and climate change as intrinsically linked and, as such, MFD revolves around deploying concessional finance with zero or low-interest charges to de-risk investment for climate change mitigation and adaptation projects to ensure that climate change does not erode the potential gains made by the SDGs (World Bank, 2021, p. 237) Secondly, there is robust evidence from the scholarship of the political economy of the climate transition that developmental co-benefits are an important source of incentives for developing countries to engage with international climate agreements (Bollen et al., 2009; Hochstetler, 2020; Mayrhofer & Gupta, 2016).

As such, it is important to look at the links between climate ambition and sustainable development.

Exploring the extent to which the two agendas are aligned by identifying examples of climate actions that have the potential to generate mutual benefits with SDG, the World Resources Institute found that climate actions were aligned with 154 of the 169 SDG targets. To score this condition I investigated the number of SDG targets referenced in each of the selected countries' NDC's text and then estimated the proportion of these with the total number of climate-aligned SDG targets; the logic being that a country's climate and sustainable development agendas would be more ambitious the larger this ratio.
Currently, the 17 SDGs and climate actions of the NDCs are still largely implemented under separate tracks. As such, theoretically, a country could be classified as a leader if it had more than 50% of the SDG/NDC ratio as it shows the importance it places on the link between the two agendas. Conversely, given that the implementation is still done under separate tracks, countries with a ratio of less than 5% could be classified as laggards. The crossover point, in this case, would be 25%. The states' scores were then calibrated along a continuous scale between these three thresholds. Strong international commitments are coded as 1.00 and weak ones as 0.00. The states' scores were then calibrated along a continuous scale between these three thresholds.

Table A 3.8 International Commitments Scores

Country	SDG Targeted	SDG/NDC Link Ratio	fsQCA Score
Argentina	6	4%	0.043
Benin	24	16%	0.200
Burkina Faso	17	11%	0.114
Burundi	14	9%	0.088
Cambodia	60	39%	0.838
Cameroon	25	16%	0.216
Ecuador	0	0%	0.025
Egypt	42	27%	0.567
Ethiopia	27	18%	0.250
Ghana	17	11%	0.114
Guinea	18	12%	0.123
India	32	21%	0.349
Madagascar	18	12%	0.123
Mauritania	11	7%	0.067
Mauritius	28	18%	0.268
Myanmar	18	12%	0.123
Nepal	33	21%	0.371
Niger	14	9%	0.088
Papua New Guinea	33	21%	0.371
Paraguay	7	5%	0.047
Seychelles	27	18%	0.250
Solomon Islands	4	3%	0.036
Tanzania	19	12%	0.134
Thailand	22	14%	0.171
Vietnam	51	33%	0.722
Zambia	55	36%	0.779

Climate Risk

It has been theorized that states that face steep economic costs given their propensity for climate-related risks such as reductions in agricultural output, rising sea-levels, floods or forced migration, can be expected to be leaders in climate mitigation policy in diverse issues such as the adoption of carbon offset projects or a general positive orientation toward a global emission protocol(Andonova & Sun, 2019; Buys et al., 2009; Christoff & Eckersley, 2011; Dolsak, 2001). Moreover, a positive association between vulnerability and better climate change adaptation policies has also been studied(Eisenstadt et al., 2019). Finally, given that many of the proposed World Bank MFD projects are on climate-resilient infrastructure for climate change adaptation in agribusiness, access to water, sanitation, finance, and power generation, it is likely that the level of climate risk a country faces will influence their environmental policy and stance towards the World Bank's MFD approach.

To score the condition of climate vulnerability I relied on the Climate Risk Index developed by Germanwatch which measures the impacts that extreme weather events have had in a country in terms of fatalities (death toll and deaths per 100,000 inhabitants) and economic losses (absolute losses and as % of GDP) to create an average ranking of countries. Crucially, the index measures climate risk as climate events that have already happened and not in potential impacts that can theoretically occur in the future. As such, island countries like Seychelles which are 'theoretically vulnerable' by being island nations but that have not had significant extreme weather events in the past 20 years will not be classified as having a high climate risk. The intuition here is that events that have already happened will motivate countries to engage more with climate action than any potential future events. In this case, I use the 2021 version of the index that collects data from 2000 to 2019 and ranks the countries most affected by extreme weather events during that 20-year period where a lower score means more climate vulnerability.

The CRI ranks 180 countries. Theoretically, the top 20 nations are the ones most at risk of extreme weather events and conversely, the bottom 20 countries of the ranking are the ones who are less impacted by these events. As such, as the threshold for inclusion, I use the scores of India (38.5) and the Republic of the Congo (148.7) – the countries ranked in the 20th and 160th spots respectively. For the crossover point, I conducted a hierarchical cluster analysis to set the threshold at 106, which also aligns with the

theoretical expectation that countries above such scores are at the edge between being at risk and being relatively safe. Here high climate risk is coded as 1.00 and low climate risk is coded as 0.00. The states' scores were then calibrated along a continuous scale between these three thresholds.

Table A 3.9 Climate Risk Scores

Country	2021 (2000-2019)	fsQCA Score
Argentina	77.00	0.78289944
Benin	139.83	0.08869442
Burkina Faso	101.00	0.55800976
Burundi	74.50	0.80090692
Cambodia	36.17	0.95556176
Cameroon	128.17	0.17963636
Ecuador	94.17	0.62989689
Egypt	142.17	0.07639189
Ethiopia	66.50	0.85091859
Ghana	101.33	0.55444756
Guinea	159.83	0.0236482
India	38.50	0.95102846
Madagascar	34.67	0.95826548
Mauritania	82.00	0.7434516
Mauritius	124.17	0.22432422
Myanmar	10.00	0.98540899
Nepal	31.33	0.96373136
Niger	68.67	0.83847525
Papua New Guinea	90.83	0.6632559
Paraguay	67.00	0.84812345
Seychelles	160.33	0.02285853
Solomon Islands	73.00	0.81116065
Tanzania	111.33	0.41393697
Thailand	29.00	0.9671294
Vietnam	35.67	0.95648106
Zambia	111.83	0.40552769

Fossil Fuel Dependency

Regarding fossil fuel dependency, Mildenberger (2020)suggests that the effective capture that fossil fuel interests have on policy is the single most important feature of climate policy conflict in advanced economies. A similar finding is presented by Bättig and Bernauer (2009, p. 289) who underline the negative influence that the lobbying of industrial sectors plays in domestic environmental policy. Taking a different line, Harrison and Sundstrom suggest that given that countries whose economies are very carbon-intensive face high marginal abatement costs, which leads to stronger business opposition to the ratification of international treaties(Harrison & Sundstrom, p. 268).. Moreover, Lachapelle and Patterson note that countries' dependency on fossil fuels results in a 'carbon lock-in' that conditions and limits policy options(2013, p. 549). On the other side, countries without, or with less access to, indigenous fossil fuel resources have longer histories of making their energy systems sustainable (Kuzemko et al., 2016). In the case of developing countries, (Rong, 2010)finds that having a strong mitigation capacity tied to a low abatement cost is important in explaining the adoption of aggressive climate policies. Conversely, Never and Betz (2014)find that dependency of fossil fuels is both a necessary and sufficient condition for weak climate policy.

However, most of the scholarship is cantered on comparing wealthy economies and has little focus on countries on the global South. These countries are particularly relevant given that they are the most vulnerable to climate-related risks (Fankhauser & McDermott, 2014) and so we could expect them to be leaders in climate policy(Christoff & Eckersley, 2011). Moreover, developing countries have more heterogenous economic and political characteristics, so variables that capture this heterogeneity, such as the development of their financial sector, how attractive they are to foreign investors, or their infrastructure policy need to be considered. In what follows I provide insights on how the interaction of these characteristics interact in developing countries to explain variations in environmental policy.

Scoring fossil fuel dependency represents a challenge given data availability and the comparability of data. Following the World Bank, I looked at net energy imports of countries defined as energy consumption minus production[14] where negative values

[14] https://databank.worldbank.org/metadataglossary/world-development-indicators/series/EG.IMP.CONS.ZS

represent that a country is a net exporter of energy and given that it has 'economic skin in the game', theoretically, it will avoid decoupling from fossil fuel sources to not lose a source of income. As such, I looked at the average production and consumption of coal, natural gas and oil of each of the countries for the period 2016-2019 to determine if a country had been a net importer or net exporter of energy during that period. Countries that were net importers of the three fossil fuels were classified as importers and were coded with 0. Countries that had been net exporters of only one energy source were coded with a fuzzy score of 0.33 and net exporters of two energy sources were coded with 0.66. Data was extracted from the U.S. Energy Information Administration.

Table A 3.10 Fossil Fuel Dependency Scores

	Fossil Fuels Net Imports (2016-2019 averages in billion m^3)				
Country	Coal	Crude oil	Natural gas	Imp/Exp	fsQCA scores
Argentina	7075	1.2599975	13.645	Importer	0
Benin	20.02775	0.1093075	2.74675	Importer	0
Burkina Faso	0	0	1.6285	Importer	0
Burundi	0	0	0.23465	Importer	0
Cambodia	0	1.824	3.1735	Importer	0
Cameroon	-627.675	0	-2.252	Exporter	0.66
Ecuador	0	0.0143	-16.0125	Exporter	0.33
Egypt	1980	3.5115	10.3125	Importer	0
Ethiopia	0	0.605175	5.1045	Importer	0
Ghana	434.37	0.058	-3.33575	Exporter	0.33
Guinea	0	0	1.15575	Importer	0
India	27360	186.3	226.52	Importer	0
Madagascar	0	0.441175	1.0879	Importer	0
Mauritania	0	0	1.300375	Importer	0
Mauritius	0	0.72015	1.90025	Importer	0
Myanmar	-13947.2	0.081875	6.837	Exporter	0.33
Nepal	0	0.449405	2.8805	Importer	0
Niger	0	0	0.037525	Importer	0
Papua New Guinea	-10768.6	0	-0.37425	Exporter	0.66
Paraguay	0	0.0024865	3.2425	Importer	0
Seychelles	0	0	0.456275	Importer	0
Solomon Islands	0	0	0.127275	Importer	0
Tanzania	0	-0.099275	3.14725	Exporter	0.33
Thailand	14835	19.0375	64.335	Importer	0
Vietnam	0	16.995	12.2075	Importer	0
Zambia	0	0.140225	1.49325	Importer	0

Summary of the outcome and conditions

A summary of the outcome and conditions and each of the thresholds I used for inclusion, exclusion and the crossover point appear in Table A.3.11

Table A 3.11Thresholds for Variables

Variable	Type	Exclusion	Crossover	Inclusion
mfd_eng	Outcome	0.19	0.47	1
econ_dev	Remote Condition	782	4285.3	22200
gov	Remote Condition	17.4	39.15	64.45
debt_gdp	Remote Condition	25	50	100
fin_dev	Remote Condition	0.10	0.23	0.57
fdi	Remote Condition	0.1	2.3	6
pd	Remote Condition	0.017	3.6	8.3
int_comm	Proximate Condition	5	25	50
cl_risk	Proximate Condition	148.67	100	39

Appendix 3.B. Truth Tables for the Outcome and the negation of the outcome.

Outcome

I created a truth table with the two conditions of the outcome-enabling context (*dev* and *debt_gdp*) and the three proximate hypotheses which lists each of the possible combinations of conditions, the number of times the configurations occurred empirically, and in the case where all cases from a given configuration are consistent with the outcome, the output column is assigned the value 1, if not it is assigned 0 and if the configuration is not found empirically, it is assigned the value "?". The resulting truth table has 32 rows representing every possible causal configuration. Of these, 12 were empirical cases and 20 were logical reminders.

Table A 3.12 Truth table for the outcome

dev	debt_gdp	int_comm	cl_risk	fossil_fuels	OUT	N	InclS
1	1	1	0	0	1	1	0.91090262
1	1	0	0	0	1	2	0.89451159
1	0	1	1	0	1	1	0.88206822
0	1	1	0	0	0	1	0.81721295
0	0	0	0	0	1	3	0.80480595
0	0	0	0	1	0	1	0.78241917
0	0	0	1	0	0	7	0.7490355
0	0	1	1	0	0	1	0.74658662
1	0	0	1	0	0	1	0.74104392
1	1	0	1	0	0	2	0.70788935
0	1	0	1	0	0	5	0.70137918
0	0	0	1	1	0	1	0.64706679
0	1	0	0	0	?	0	-
0	1	0	0	1	?	0	-
0	1	0	1	1	?	0	-
0	1	1	0	1	?	0	-
0	1	1	1	0	?	0	-
0	1	1	1	1	?	0	-
0	0	1	0	0	?	0	-
0	0	1	0	1	?	0	-
0	0	1	1	1	?	0	-
1	0	0	0	0	?	0	-
1	0	0	0	1	?	0	-
1	0	0	1	1	?	0	-
1	0	1	0	0	?	0	-
1	0	1	0	1	?	0	-
1	0	1	1	1	?	0	-
1	1	0	0	1	?	0	-
1	1	0	1	1	?	0	-
1	1	1	0	1	?	0	-
1	1	1	1	0	?	0	-
1	1	1	1	1	?	0	-

Negation of the Outcome.

Alternatively I created a truth table with the necessary condition for the negation of the outcome (*hipc*) and the three proximate hypotheses which lists each of the possible combinations of conditions, the number of times the configurations occurred empirically, and in the case where all cases from a given configuration are consistent with the outcome, the output column is assigned the value 1, if not it is assigned 0 and if the configuration is not found empirically, it is assigned the value "?". The resulting truth table has 16 rows representing every possible causal configuration. Of these, 9 were empirical cases and 7 were logical reminders.

Table A 3.13 Truth table for the negation of the outcome

hipc	int_comm	cl_risk	fossil_fuels	OUT	n	InclS
1	0	1	1	1	1	0.9924511
1	1	1	0	1	1	0.87983214
1	0	1	0	1	13	0.81160732
1	0	0	1	1	1	0.77351369
0	1	1	0	0	1	0.8564486
0	0	0	0	0	2	0.81923261
1	1	0	0	0	2	0.81096798
0	0	1	0	0	2	0.80449449
1	0	0	0	0	3	0.71908544
0	0	0	1	?	0	-
0	0	1	1	?	0	-
0	1	0	0	?	0	-
0	1	0	1	?	0	-
0	1	1	1	?	0	-
1	1	0	1	?	0	-
1	1	1	1	?	0	-

Appendix 3.C. Solutions for the outcome

Based on how we choose to deal with the issue of logical reminders, we can obtain a conservative (no simplifying assumptions), an intermediate (minimization based on counterfactuals that are consistent with our theoretical expectations) or a parsimonious solution (one based on the assumption that all configurations for which there are no empirical instances would result in a positive outcome if they were actually observed). The simplifying assumptions for the intermediate solution are in line with the theoretical expectations mentioned in the main body except in the cases where the analysis of necessity suggested that the opposite was the case. Here I present the three solutions for the outcome and the negation of the outcome.

Table A 3.14 Conservative Solution

Causal configuration	InclS	Raw Coverage	Unique Coverage
dev*debt_gdp*~cl_risk*~fossil_fuels	0.903	0.289	0.088
debt_gdp*int_comm*~cl_risk*~fossil_fuels	0.836	0.244	0.014
~dev*~debt_gdp*~int_comm*~cl_risk*~fossil_fuels	0.805	0.371	0.172
dev*~debt_gdp*int_comm*cl_risk*~fossil_fuels	0.882	0.208	0.107
Overall solution	0.828	0.635	-

Table A 3.15 Parsimonious Solution

Causal configuration	InclS	Raw Coverage	Unique Coverage
dev*int_comm	0.910	0.305	0.123
dev*~cl_risk	0.888	0.299	0.088
~debt_gdp*~cl_risk*~fossil_fuels	0.806	0.374	0.217
Overall solution	0.860	0.639	-

Table A 3.16 Intermediate Solution

Causal configuration	InclS	Raw Coverage	Unique Coverage
dev*~cl_risk*~fossil_fuels	0.888	0.299	0.142
~debt_gdp*~cl_risk*~fossil_fuels	0.806	0.374	0.217
dev*~debt_gdp*int_comm*~fossil_fuels	0.894	0.234	0.107
Overall solution	0.860	0.622	-

Appendix 3.D. Solutions for the negation of the outcome

Table A 3.17 Conservative Solution

Causal configuration	InclS	Raw Coverage	Unique Coverage
hipc*~int_comm*fossil_fuels	0.827	0.157	0.030
hipc*cl_risk*~fossil_fuels	0.776	0.720	0.593
Overall solution	0.757	0.750	-

Table A 3.18 Parsimonious Solution

Causal configuration	InclS	Raw Coverage	Unique Coverage
hipc*cl_risk	0.781	0.744	0.593
hipc*fossil_fuels	0.829	0.159	0.009
Overall solution	0.758	0.752	-

Table A 3.19 Intermediate Solution

Causal configuration	InclS	Raw Coverage	Unique Coverage
hipc*cl_risk	0.781	0.744	0.595
hipc*~int_comm*fossil_fuels	0.827	0.157	0.009
Overall solution	0.758	0.764	-

Thesis Conclusion

Transitioning to a low-carbon economy will require the effective deployment of financing at vast scale. Although different sources estimate different levels of investment needed for this transition, what is clear is that the current levels of climate finance are insufficient (CPI, 2023; UNEP, 2022; UNFCCC Standing Committee on Finance, 2022).

In order to close this 'financing gap', the climate finance system is increasingly shifting toward mobilizing private capital markets, reflecting a significant "private turn" in recent years. This shift seeks to harness national and international capital markets to drive sustainable and climate-related investments, assuming the private sector will provide a large share of the additional climate finance needed. Despite extensive scholarship on international climate institutions, much of the focus has been on market mechanisms like carbon pricing and carbon markets in developed countries or concessional finance in emerging economies. While this literature has clarified the progress and limitations of these instruments, it has overlooked the role of new financial instruments, such as green bonds and blended finance, and the broader politico-economic institutions not explicitly designed for climate finance.

This thesis addressed this gap by examining the roles of institutions like central banks, regulatory bodies, and development banks in mobilizing climate finance. It highlighted how these traditional institutions, operating outside the direct sphere of climate governance, are using innovative instruments like blended finance to drive transitions in sustainable sectors. Against the backdrop of increasingly complex global environmental governance, characterized by institutional proliferation, this research built on existing literature to explore the dynamics of climate finance through three analytical case studies. These studies illuminated the political-economic factors influencing the effectiveness of traditional institutions in enabling the large-scale sectoral transitions necessary for addressing the climate crisis.

Findings

Paper 1 examined the effect that the announcement of the EU Green Bond Standard had on the European Green Bond Market. There is a broad strand of research on the interaction between public and private regulatory initiatives that suggests that private governance initiatives and regulations can serve as a political strategy to preempt more

stringent public regulations by crowding out the demand for governmental interventions (Kolcava et al., 2021; Lyon & Maxwell, 2004; Malhotra et al., 2019; Potoski & Prakash, 2013; Rhein & Sträter, 2021). Given that a large private market for verifying the green bonds market is already well-established, theoretically we could expect public regulatory initiatives such as the EU Standard to have a limited impact given that it would compete with this well-established private regulatory framework. However, I argued that given the breadth of asymmetry in the green bond market and the potential for greenwashing this could open the door for a public regulatory standard to have a pronounced effect. I tested my argument using a regression discontinuity in time analysis and the results showed that the announcement of the EU GBS led to a significant increase in green bond yields, reflecting a shift in investor behavior towards greater caution and scrutiny. Moreover, they also showed that this effect is mediated by the environmental reputation of the issuers as bonds issued by firms classified as environmental leaders have a less pronounced effect than firms classified as environmental laggards.

Paper 2 analyzed the effect that the European Central Bank's monetary operations in the form of their collateral framework have on green bond prices. In this case, there is a wide array of scholarship on the policy of market neutrality under which the ECB values the assets it accepts as collateral. Nonetheless, given that the ECB's asset purchases are done in proportion to the market index of the assets it purchases this entails that, in practice, it is biased towards carbon-intensive sectors as these tend to be more capital-intensive (Boneva et al., 2022; Dafermos et al., 2021; Jourdan & Kalinowski, 2019; Matikainen et al., 2017; McConnell et al., 2022; Monnin, 2018; Papoutsi et al., 2021; van 't Klooster & Fontan, 2020). n this paper, I offered a thematic extension to this argument. Theoretically, I suggested that this carbon bias in the ECB collateral framework also extends to green assets in the form of an anti-green bias. I tested my hypothesis by matching identical pairs of green and conventional bonds and testing the effect that being labelled green has on their haircuts and yield spreads. The results showed that green bonds face more conservative haircuts, thus increasing their yields (in turn decreasing their prices) and hence limiting their effectiveness in mobilizing additional climate finance.

Paper 3 examined the use of blended finance instruments by IFIs in developing countries. Given that developing countries face several institutional and market barriers to accessing green bond markets (Banga, 2019), here I tested whether the World Bank can leverage blended finance instruments effectively to mobilize climate finance to developing

countries. I engaged with the scholarship that highlights the tension in the World Bank between its donor interests and recipient need (Blair et al., 2022; Clegg, 2017; Graham & Serdaru, 2020; Gutner, 2005a; Michaelowa & Michaelowa, 2011; Wade, 1997). I argued that given this tension, the World Bank would favor its donor interests by showing a middle-income bias given that these countries would create higher returns for its investors and leave low-income nations behind. I tested this argument using Qualitative Comparative Analysis. My results show how MFD disproportionately benefits wealthier nations, with more developed financial systems and stronger levels of governance efficiency as private investors are more likely to fund projects in stable environments with predictable returns. In contrast, countries with fragile economies or governance structures struggle to attract private finance, even with the World Bank's blended finance instruments.

In addition to the findings specific to each case study, this thesis also investigated how institutional design influences climate finance flows, outlining a roadmap of factors enabling effective mobilization. Through these three case studies, it explored variations in performance outlining features enhancing climate finance capacity and action. The results, taken together, suggest that the alignment between formal rules, informal norms, and enforcement mechanisms is a crucial determinant of the effectiveness of climate finance mobilization.

Contributions and implications

I contribute to the literature on climate finance by arguing that "non-climate" institutions significantly influence climate finance dynamics, often more so than explicitly climate-focused entities. While prior research has extensively examined climate-specific institutions, less attention has been given to how broader political and economic institutions shape climate finance outcomes in the global push to decarbonize the economy, such as through the development of innovative financial instruments like green bonds and blended finance. Here I shift the focus from traditional climate institutions to broader institutions, such as regulatory bodies, central banks, and development banks. These entities, though not initially created for climate purposes, have become instrumental in mobilizing climate finance. For example, they govern financial regulations and resource allocations that directly affect green investments. This analysis

highlights that effective climate governance often extends beyond the traditional boundaries of climate institutions, with non-climate actors playing a pivotal role in shaping outcomes.

First, this thesis empirically and theoretically examines the EU Green Bond Standard (EU GBS) to understand its impact on green finance. The thesis argues that public regulatory standards, such as the EU GBS, reduce risks like greenwashing more effectively than private initiatives. Public standards offer greater transparency and mitigate information asymmetry, fostering trust in green finance markets. While private governance initiatives often precede stricter public standards, their lack of uniformity can create vulnerabilities. Furthermore, the thesis explores how environmental regulations, like the EU GBS, can stimulate innovation, aligning with theories like the Porter Hypothesis. Although the EU GBS initially increased green bond yields and created short-term challenges for issuers, it set higher environmental benchmarks, potentially driving a global "trading up" of standards among firms seeking sustainable investments.

As such, by showing the heterogeneous effects of the EU's Green bond standard that are mediated by a firm's reputation as either an environmental leader or laggard, I contribute to the ongoing debate on the effectiveness of regulatory standards in green finance. In particular, I engage with the work that explains the politico-economic regulatory effects of environmental regulation and the firm-level characteristics that shape the heterogeneity of these effects (Bayer, 2023; Bechtel et al., 2019; Brulle, 2021; Cheon & Urpelainen, 2013; Genovese, 2021; Genovese & Tvinnereim, 2019; Kelsey, 2018; Kennard, 2020; Kim et al., 2016; Lerner & Osgood, 2023; Meckling, 2015).

Secondly, the thesis investigates the political economy of central banking and its intersection with climate finance, particularly the unintended consequences of European Central Bank (ECB) policies. It introduces the concepts of "carbon bias" (favorable treatment of carbon-intensive assets) and "anti-green bias" (undervaluation of green bonds due to their labelling) to explain how ECB operations affect green finance. The analysis reveals that the ECB's collateral frameworks and valuation practices indirectly shape green bond markets, demonstrating how broader politico-economic policies influence climate finance.

By showcasing the unintended consequences of the ECB's policy of market neutrality in the pricing dynamics of green bonds, I contribute to the literature of the impact of central banks on financial markets (Abidi & Miquel-Flores, 2018; Andrade et al., 2016; De Santis, 2020; Eser et al., 2019; Galema & Lugo, 2021; Li et al., 2021; Pelizzon et al., 2023) and, in particular, to the literature that emphasizes the limitations of the environmental turn in central banking (Boneva et al., 2022; Dafermos et al., 2021; Jourdan & Kalinowski, 2019; McConnell et al., 2022; Monnin, 2018; Schoenmaker, 2021).

Moreover, by looking at how policy decisions such as EU regulation or asset purchases by central banks also impact the pricing dynamics of financial instruments, I contribute to the financial economics literature on green bond prices that is mostly focused on the internal financial and environmental characteristics of bonds and environmental drivers that might lead investors to prefer one type of asset over the other with no attention paid to some of the wider politico-economic factors that can influence bond prices (Agliardi & Agliardi, 2019; Larcker & Watts, 2020; MacAskill et al., 2021; Simeth, 2022; Zerbib, 2019).

Finally, the thesis also evaluates the World Bank's evolving role in mobilizing private finance for climate adaptation and mitigation. It critiques the Maximizing Finance for Development (MFD) agenda, which prioritizes private capital mobilization over developmental needs. The thesis argues that high debt levels and weak governance in vulnerable countries limit the effectiveness of blended finance instruments. Comparisons with the World Bank's historical success in public finance underscore the inadequacy of the MFD framework for addressing the needs of the poorest nations.

Here, I contribute to the comparative literature on variation in climate policy by analyzing developing countries, which except for some notable exceptions (Never & Betz, 2014) have been generally overlooked. By focusing on the use of blended finance instruments by the World Bank to 'crowd-in' private investment in developing countries. I also contribute to the literature on climate finance as development aid, which mostly focuses on concessional finance (Eisenstadt et al., 2021; Graham & Serdaru, 2020; Michaelowa & Michaelowa, 2011; Michaelowa et al., 2020). Primarily, however, I contribute to the scholarship on the World Bank-borrower country relationship, which has identified the structural tension within the institution between its role as a bank and its role as a development agency.

Avenues for future research

The evolving landscape of climate finance, which now includes traditionally non-climate-focused institutions such as financial institutions and regulatory agencies, corporations, and regional and transnational governance bodies, raises critical questions about how these entities interact with climate-specific institutions at both international and domestic levels. As such, my thesis suggests interesting questions that are worth exploring in further research both at the domestic and international levels.

At the international level, climate finance institutions consist primarily of bilateral aid agencies and a range of multilateral funds, such as the Global Environmental Facility and the Green Climate Fund. We have recently witnessed an "institutional proliferation" of such organizations, creating a climate financing regime that is further complicated by the entry of financial regulators, central banks, and other agencies into climate finance governance. This climate financing regime complexity has been under-theorized and underexplored empirically

For instance, some research suggests that overlapping institutions may reduce cooperation by increasing the number of coordination points. Theoretically, states could exploit this institutional density to backtrack on their commitments to provide new and additional finance, claiming that private finance mobilized through non-climate institutions fulfils their national obligations. Conversely, as suggested by the scholarship on regime complexity and polycentric governance, the high demand for access to resources from international climate finance institutions (ICFIs), which far exceeds supply, suggests that mobilizing climate finance through non-climate institutions could complement existing efforts. Additionally, given that finance mobilized through non-climate institutions does not typically count against a state's balance sheet, additional research should focus on the benefits of such strategies drawing on literature regarding the political acceptability of environmental policy.

At the domestic level, there are two important areas to investigate. First, while the relationship between domestic policies, interests, and climate institutions has been widely studied, the rise of green industrial policies in advanced economies raises new questions about their impact on climate finance flows. Specifically, interesting questions arise regarding the divergence between green industrial policies based on tax credits, as in the

U.S. Inflation Reduction Act and approaches that are reform- and regulation-centered, such as the EU Green Deal and the different outcomes they produce in the mobilization and distribution of climate finance. Second, there has been a tendency in environmental policy research to focus on policy outputs rather than performance. This leaves an important gap regarding the effects of institutions on climate outcomes. Moreover, as non-climate financial institutions take on a larger role in mobilizing climate finance, their impact on environmental outcomes warrants empirical investigation.

Finally, in the introduction of this thesis, I outline a 'pocket map' of the institutional factors that support effective climate finance performance across different levels and forms. I suggest that for effective mobilization of climate finance, there needs to be alignment between an institution's formal and informal rules as well as its enforcement mechanisms. However, this is only theoretically hinted at throughout the thesis and not explored empirically to its full extent. As such, future research should further explore how these alignments—or misalignments—impact the broader landscape of climate finance, particularly as new actors and mechanisms emerge to meet the growing demand for sustainable investment.

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