PUBLIC SECTOR GREEN BONDS: LEGACY, ISSUANCE STRATEGIES AND COST

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Abstract

Though public sector issuers were essential in the early phases of the green bonds – by conceiving them and playing a stewardship role – and still cover above one third of the market, those green bonds issued by public sector institutions are under-studied. To value that legacy and promise, we concentrate on the issuance strategies and the cost of issuing for public sector entities (Supranationals, Sovereigns, Local Governments), investigating the factors which drive the performance of their green bonds. We measure performance in two innovative ways by identifying: i) across issuer types, which issuance strategies pursue general- rather than local-goals in the destination of the green bond proceeds, so broadening the green impact; ii) which factors reduce the cost of funding. Based on a sample of 279 green bonds, our econometric analysis reaches two main sets of results. First, in terms of strategies, issues more likely target general-goals if they either come from Supranationals or have a more concentrated use of proceeds. Second, our evidence on the cost of funding reveals that the yields on green bonds required by investors are higher when they are issued by Supranationals while they drop when the use of proceeds is more concentrated or the issue size is larger. Implications can be drawn for policy makers towards optimizing the structure of the green bond market and the associated issuance strategies.

JEL Codes: G15; H23; H73; Q56.
Keywords: Green Bonds; Public Sector Entities; General- vs Local-Goals; Issuance Strategies; Cost of Funding; Yield-to-Maturity; Financing Sustainable Transition.

1. Introduction

Finance has been identified as the main enabling driver behind the green transition. This is exemplary for the European Union, where the launch of the European Green Deal (December 2019) was preceded by the introduction of the Action Plan on Sustainable Finance (March 2018). The part of finance which is designed to support the green transition is called "green finance" and often refers to the ESG (Environmental, Social, Governance) metrics. It contains green bonds, green loans, green equity instruments, in which sustainable asset managers have been investing massively especially after the launch, in 2015, of the 2030 Agenda for Sustainable Development of the United Nations and of the Paris Agreement on climate change. Within green finance, we concentrate on the green bonds issued by public sector entities – in order of appearance, Supranational entities (SNATs), Local Governments (LGs), and Sovereigns (SOVs). The fact that these green bonds represent up to now an

under-researched area of finance seems to be a puzzle. As we detail in the Appendix, the first green bond was issued by a SNAT in 2007 and for the following five years the market was totally dominated by public sector issuers. Thereafter, since 2013, there was a boom for the market which was largely driven by corporate green bonds. The surge in the academic literature has mostly focused on corporate green bonds. However, this fails to acknowledge the legacy of public sector green bonds which, evidently, exercised a stewardship role in the infant phase of the market and still represent above one third of the entire green bond market (with total issues for € 1.07 trillion in the 2007-2024 period, representing 36% of the market; € 190.8 billion of issues and 34% market share in 2024). Therefore, studying the peculiarities of public sector green bonds appears essential to achieve a full understanding of this type of debt instruments.

In particular, investigations have so far looked at: 1) the corporate green bonds' convenience and pricing in the primary and secondary market versus conventional bonds (Gianfrate and Peri, 2019; Fatica et al., 2021) as well as the hedging opportunities through diversification (Rehman et al., 2023); 2) the ex post environmental performance of issuers and the credible signaling of their commitment toward the environment (Flammer, 2021; Tuhkanen and Vulturius, 2022; Ahmed et al., 2024), also related to the corporate exposure to climate change (Fatica and Panzica, 2021; Guesmi et al., 2025); 3) the abnormal announcement returns (Glavas, 2018; Baulkaran, 2019; Kuchin et al., 2019; Wang et al., 2020; Flammer, 2021; Ahmed et al., 2024; Siddique et al., 2024); 4) the overall positive spillover effects on shareholders (Tang and Zhang, 2020), on the equity market (Bouteska et al., (2025) and on the cost of capital (Zhang et al., 2021; Ruan et al., 2025); 5) the existence of a "green premium" (Hachenberg and Schiereck, 2018; Bachelet et al., 2019; Zerbib, 2019; Löffler et al., 2021; Caramichael and Rapp, 2024; Feldhütter et al., 2024); 6) the possible liquidity disadvantage for green bonds issues relative to conventional bonds (Yan et al., 2025); 7) the impact of macroeconomic, political-institutional and cultural features on the propensity to issue corporate green bonds (Mertzanis and Tebourbi, 2024; 2025).

On the opposite, as said, little is known yet on the segment of green bonds issued by public sector entities. To the best of our knowledge, this is the first study comprehensively investigating public sector green bonds. In this respect, we concentrate on the issuance strategies and the cost of issuing for public sector entities, searching for the factors driving the performance of the green bonds they issue. Specifically, we measure public sector green bond performance along two dimensions: (i) the extent to which different types of issues accelerate the green transition, where better performance means faster acceleration (issuance strategies); (ii) the prospective cost of funding (henceforth, simply cost of funding) for the issuer, where a lower yield implies that the issuer saves on interest expenses. In particular, in studying public sector green bond issuance strategies, we innovate by tracing the

distribution of the proceeds from these bonds to diverse classes of beneficiaries distinguishing between general- vs local-goals, where supporting general-goals – e.g., CO2 reduction – appears to be more critical than supporting local-goals – e.g., building a flood barrier. General-goals are, in fact, typically linked to mitigation actions producing public goods for every inhabitant of the planet, while supporting local-goals often leads to adaptation actions motivated by self-interest and producing private goods with a localized impact. Our innovation partly builds on an emerging strand of literature on the politics of green bond issuance, showing that political values impact green bond issues by public sector entities (Niczyporuk, 2020; Chang et al., 2024).

Our second innovation consists in investigating the main determinants of the cost of funding of green bonds issued by public sector entities. In particular, rather than looking at the cost of funding at issue – observed on the primary market – we focus on the secondary market yield-to-maturity, representing exactly the cost of funding should the issuer decide to issue a new otherwise analogous green bond on the spot. As such, the observations of the cost of funding coming from the primary market are more limited in terms of numerosity and, in addition, these observations may reflect conditioning factors of convenience or external needs by the issuer. The observations of the (bid-ask spread) yields on the secondary market are, instead, free from those possible conditioning factors and signal the actual market demand by investors for a specific green bond. A further advantage of using these bid-ask spread quotes is that they largely reflect the issuer's risk of default (O'Sullivan et al., 2024), the most obvious determinant of the cost of funding. Moreover, secondary market yields are understudied in the green bond segment (Löffler et al., 2021). By doing so, we also respond to Russo et al. (2021) who call for further research on the determinants of the performance of green bonds issued by Supranational, Sovereign or Local Government entities, with specific regard to the nature of projects financed through green bond issues. Both innovations put our analysis in the double materiality framework, where the green impact (impact materiality) and the cost of funding (financial materiality) are jointly considered.

Our analysis exploits a sample of 279 public sector green bonds for which we could retrieve key financial data from Bloomberg and hand-collect additional information from periodic post-issuance reports. We reach five main findings. First, the green bonds issued by SNATs more likely pursue general-goals, highlighting the importance of issuance strategies. This is an interesting result because of two considerations. Indeed, on one hand, it is documented that the effectiveness of green bonds issued by public sector entities is higher in terms of pursuing the green transition by: i) more likely avoiding greenwashing (Baldi and Pandimiglio, 2022); ii) enjoying a higher credibility for investors as reflected in the larger *greenium* (Kapraun et al., 2021); iii) minimizing the requirement

of costly third-party certification (Flammer, 2020). On the other hand, however, our novel finding is that the extent of such effectiveness differs significantly across types of public sector issuers.

Second, public sector green bonds – interestingly also those issued by Local Governments – more likely address general-goals when the use of proceeds is more concentrated (*focused* GREEN BONDs). Once more, issuance strategies matter. This result is linked to our first finding. The higher ability of SNATs to pursue general-goals may descend from being less likely captured by local constituencies (Gonschorek et al., 2018; Owen, 2019; Däubler, 2020).

Third, *focused* green bonds enjoy a lower cost of funding. Presumably, this is derived from investors' expectations that a green bond having a more focused allocation of its proceeds undergoes a lower risk of not achieving its target, in line with the literature on the diversification discount (Baker, 1992; Lang and Stulz, 1994; Rajan et al., 2000; Laeven and Levine, 2007; Ivković et al., 2008).

Fourth, the green bonds issued by SNATs pay a higher cost of funds. This is apparently linked to the fact that SNATs, being distant financiers, undergo more intense agency problems (Fama and Jensen, 1983) and are less effective at monitoring the implementation of the projects they finance (Baldi and Pandimiglio, 2022).

Fifth, the public sector green bonds having larger issues pay a lower cost of funds. This is supposedly originating from the fact that larger issues: i) enjoy higher liquidity and face less price pressure (Helwege and Wang, 2021); ii) attract monitoring by more analysts (Marquardt and Wiedman, 2005) as well as more coverage by the rating agencies (Fabozzi et al., 2014), thus reducing information asymmetries (Zhang et al., 2021); iii) tend to finance more impactful projects convincing investors to accept lower returns (Baldi and Pandimiglio, 2022).

This paper contributes to several strands of the literature. Firstly, we contribute to the extant research on green bonds by delving into public sector issues, the area from which green bonds originated and is yet under-researched. By unveiling new aspects of public sector green bonds, not only we pay respect to the legacy of their founding role, but we also address a segment representing above one third of the entire market. Secondly, in the spirit of double materiality, a further contribution consists in investigating both the issuance strategies and the cost of funding. The former shape the effectiveness of how much public sector green bonds promote the green transition; the latter relates to financial materiality. In both ways we contribute to the literature on impact investing. Thirdly, we contribute to the emerging literature on the political economy of green bond issuance. Lastly, we contribute to the literature on bond markets by uncovering that some of the regularities found for green bonds in general – i.e., for issuers, yields become more favorable as the issue size gets larger or agency conflicts lessen – also apply to public sector green bonds.

The paper is organized as follows. Section 2 contains a review of the relevant literature and develops the hypotheses subjected to subsequent empirical validation. In Section 3 we describe the data used in our empirical analyses – which are further detailed in the Appendix –, outline our methodology, and display and discuss our main findings. Section 4 presents the robustness analyses conducted to corroborate our empirical results. Section 5 concludes proposing implications for policy and research.

2. Literature Review and Hypothesis Development

2.1 Literature Review

In the wake of the rapid growth of green bond issuing in global capital markets, research has devoted its attention mainly to corporate issues. Five main streams of literature can be identified. First, some authors look at the stock market reaction to green bond issues (Baulkaran, 2019; Flammer, 2021; Glavas, 2018; Kuchin et al., 2019; Tang and Zhang, 2020; Bouteska et al., 2025). Second, several studies measure the green premium – or *greenium* or *sustainium* – implying a lower yield-to-maturity for green bonds compared to traditional bonds (Hachenberg and Schiereck, 2018; Bachelet et al., 2019; Zerbib, 2019; Wang et al., 2020; Löffler et al., 2021; Li et al., 2023; Caramichael and Rapp, 2024; Feldhütter et al., 2024). Interestingly, Feldhütter et al. (2024) extend the concept of green premium from green bonds to sustainability-linked bonds (SLBs) showing that the latter bonds trade at higher prices than ordinary bonds issued by the same firm – i.e., there is a positive SLB premium (*sustainium*) – since investors reward the SLBs' ESG label. Third, other works show that the cost of capital may decline for green bond issuers (Zhang et al., 2021; Ruan et al., 2025), but this benefit may be partially offset by a liquidity disadvantage (Yan et al., 2025). Fourth, various papers find that green bonds may play a role of safe heaven during market turmoil or disruptive events (Meo et al., 2025; Gronwald and Wadud, 2025; Kanamura, 2025). Fifth, it has been shown that green bond issuance may be affected both by macro determinants such as national culture (Mertzanis and Tebourbi, 2024) or geopolitical risk (Mertzanis and Tebourbi, 2025) and by micro features of the issuers such as the carbon intensity of their assets (Fatica and Panzica, 2021) or their exposure to climate change (Guesmi et al., 2025).

Among the few academic works which have addressed public sector green bonds, Braga (2020) surveys the literature and suggests that although the public sector has traditionally played a key role in mitigating environmental uncertainties and in reducing green initiatives' costs, the performance of public sector green bonds is understudied. Regarding municipal bonds, Karpf and Mandel (2018) uncover that green issues seem to pay lower returns than comparable conventional bonds (so they enjoy a *greenium*). However, still on US municipal bonds, while Baker et al. (2022)

seem to concur with the previous findings, Larcker and Watts (2020) fail to detect a *greenium*. More recently, Li et al. (2023), investigating the municipal bonds issued in the U.S., document the existence of a post-2018 *greenium*, while Sojoudi et al. (2025) confirm the *greenium* also on the basis of a novel term structure analysis. Still referring to municipal green bonds, this time in China, Zhang and Guo (2025) find that the issuance of these bonds contributes to reducing carbon emissions. In turn, Wiśniewski and Zieliński (2019) advocate the issuance of sovereign green bonds as the easiest way to attract investors and potentially increase issue size which can contribute to lower the costs of financing green public tasks. Still on this, Doronzo et al. (2021), even though they fail to find a *greenium*, claim that sovereign green bonds are a valid tool for mitigating environmental risks and coping with the intergenerational trade-offs implied by climate-related policies. In the same vein, Dell'Atti et al. (2022) argue that sovereign green bond issues lower the cost of debt and country risk, while also signaling the country's commitment toward a greener economy. Furthermore, Cheng et al. (2024) identify a series of benefits a country enjoys after its debut with issuing sovereign green bonds: i) the number and the size of corporate green bond issues increase; ii) for corporate green bonds there is an increase in liquidity and a drop in yield spreads; iii) the quality of green verification standards in the corporate bond market improves. On their part, Heine et al. (2019) argue that public sector green bonds may exert a stewardship in terms of accelerating sustainable transition, especially if those issues are coupled with active carbon pricing policies. Specifically, they argue that the issuance of green bonds helps to enable immediate investment in climate change mitigation and adaptation, and the bonds would be repaid by future generations in such a way that those who benefit from reduced future environmental damage share in the burden of financing the mitigation efforts undertaken today. Finally, from a political economy standpoint, Chang et al. (2024) find that local political preferences affect the issuance and pricing of municipal green bonds in the U.S., showing that municipalities in Democratic (Republican) states are more (less) likely to issue green bonds. On the contrary, Niczyporuk (2020) shows that green bonds are the preferred choice of right-wing governments as a market-based solution.

2.2 Hypothesis Development

Our study contributes to fill the research gap on public sector green bonds by proposing two innovations both related to the performance of these bonds in terms of their: (i) green impact; (ii) contribution to lower issuers' cost of funding. In particular, our twofold contribution consists in studying whether across the three categories of public sector issuers – Supranational, Sovereign, or Local Government entities – differences emerge in terms of strategic goals pursued through the issuance of a green bond – in line with what Lin and Su (2022) address for corporate green bonds –

and/or the perspective interest cost saving effect of that issue. In other terms, these two aspects of performance – relating, respectively, to the green impact (impact materiality) and the cost of funding (financial materiality) – can be viewed as separate but interconnected as it happens with the double materiality approach (Oman et al., 2024). In the following, we will root the development of our six testable hypotheses – the first three (*H1*, *H2*, *H2a*) on the green impact; the other ones (*H3*, *H4*, *H5*) on the cost of funding – in the relevant literature and policy/regulatory framework.

Regarding the green impact, an aspect deserving further attention lies in the possible differences in the strategic motivations driving the three types of public sector entities when deciding to issue a green bond. The first important distinction is differentiating between SNATs (SNAT GREEN BONDs) and Central Government (SOV GREEN BONDs) on one hand vs Local Government (often Municipal GREEN BONDs) on the other hand. Following Arends (2020), we may recognize that the long-held benefits of fiscal devolution (Tanzi, 1996) are now increasingly challenged. Namely, along the intuition of Rodríguez-Pose and Gill (2005), Arends underlines the dangers of decentralization with regard to public service delivery according to three dimensions: a) inefficient service delivery, b) unequal service delivery, and c) unaccountable service delivery. While we pass on the first two dimensions, which seem less material for the issue we study here, the dangers of fiscal devolution relating to unaccountable service delivery appear instead quite relevant. These dangers involve lack of adequate accountability up to corruption. In turn, this type of dangers might open the way for local politicians engaging in nudging their local constituencies towards re-election (Gonschorek et al., 2018; Owen, 2019; Däubler, 2020). Moving from fiscal devolution to the green transition, by analyzing the 2015 Colombian mayoral elections, for example, Cunial (2021) shows that municipalities that had a mayor aligned with the national incumbent party received on average U.S.$256 per capita – from the subnational distribution of subsidies for the development of small-scale solar projects in non-interconnected municipalities – more than those in which the mayor was not politically aligned.

Relating the above to our paper, we may hypothesize that the strategic motivation behind the issuance of green bonds by Local Governments could differ from the one behind the issuance of green bonds by SNATs. On one hand, we might expect the SNATs – being unconstrained from local constituencies – to be able to pursue issues that are both more concentrated on general-goals and more focused on fewer classes of beneficiaries. This leads us to expect that the green bonds issued by the SNATs will concentrate their proceeds on fewer classes. On the other hand, instead, Local Governments – due to the restraints from their local constituencies resulting from their proximity to governed territories – might end up pursuing issues which are more devoted to local-goals and perhaps also more dispersed across classes, in the attempt to satisfy the needs of all groups of

electorates. Namely, supranational organizations, while working to promote the interests of transnational society (Stone Sweet and Sandholtz, 1997), may devote funds to infrastructure investments so as to achieve general-goals such as regional competitiveness, employment, or international territorial cooperation (de Rus and Socorro, 2010). On the opposite, we anticipate that Local Governments' issues will be less devoted to general-goals. In this regard, we follow Goeminne and Smolders (2014), who – building on the idea that maximization of voter support is the main objective of politicians when outlining fiscal policy in general and, investment policy in particular – show that in Flemish municipalities (with common political systems and electoral rules) significantly higher infrastructure investment levels were recorded in years preceding elections contrary to post-election years. This suggests that the timing of elections matters for the level of public infrastructure investments by local governments. These considerations lead us to hypothesize that the issues by the SNATs (at one extreme) could differ from those by Local Governments (at the other extreme). Hence, our first testable hypothesis runs as follows:

H1. The green bonds issued by the SNATs (Local Governments), due to the lack (presence) of constraints from local constituencies, will more (less) likely pursue general-goals (i.e., 1. Renewable Energy; 2. Electricity and Gas).

In addition, there could be a benefit of concentrating the proceeds. The possible advantages of having a more focused destination of the proceeds may be anchored to evidence available both in the broader management literature and in finance studies. With regard to a firm's strategy, being focused is a primary task of leadership (Goleman, 2013). As a result, focused firms tend to have better investment opportunities (Wernerfelt and Montgomery, 1988) and their capital investments create more value (Chen, 2006). From a financial standpoint, in the context of financial intermediaries, Allen and Santomero (2001) argue that "increasingly, single-purpose providers have successfully competed for some of the most profitable traditional bank products provided by full-service banking institutions". In turn, Turley and Semple (2013) claim that single-purpose Public-Private Partnerships may provide a better target than multi-purpose PPP initiatives. Also, in project finance the single purpose attribute of this type of financing simplifies the evaluation of project viability by lenders. Hence, the high agency cost associated with corporate finance investments is reduced under project finance because the contractual arrangement in the latter context permits little margin for independence by the parties (Ghersi & Sabal, 2012). A further aspect worth mentioning is the possible analogy with the diversification discount in corporate evaluation. For example, Hadlock et al. (2001) and Thomas (2002) highlight the relationship between corporate diversification and the level of

information asymmetry between managers and outsiders. Along their transparency hypothesis, corporate diversification heightens information asymmetry for two reasons. First, diversified firms are less transparent compared to focused firms because unlike managers, outsiders can only observe the aggregated cash flows and not the cash flows of individual segments. Second, financial analysts who usually dedicate themselves to one or two industries, may be little prepared to evaluate diversified firms that operate in several different industries. Hence, we can formulate the next testable hypothesis.

H2. The green bonds will more likely address general goals when the use of proceeds from the issuance is more concentrated.

From a different angle, there is increasing evidence that local politics impacts the ESG/CSR performance in the different jurisdictions (Flammer and Kacperczyk, 2016; Flammer, 2018). In this sense, local governments are viewed as often subject to the capture by their local constituencies (Däubler, 2020; Gonschorek et al., 2018; Owen, 2019). In turn, the proceeds of local governments' issues of green bonds might have a scatter distribution in line with pursuing local-goals. Therefore, when such a capture diminishes, we expect that not only pursuing general-goals will become more likely (*H1*), but also the issues of local governments will be less dispersed across classes of beneficiaries. This leads us to formulate the next testable hypothesis.

H2a. The green bonds of Local Governments will more likely address general-goals when the use of proceeds from the issuance is more concentrated, indicating situations in which the Local Governments enjoy milder constraints from local constituencies.

We might also expect that investors prefer focused green bond issues. In fact, green bonds having a more focused allocation of their proceeds could also reduce the risk of not achieving their target. As such, we can formulate a third testable hypothesis.

H3. The green bonds issued with a more intense focus of their proceeds will enjoy a lower (prospective) cost of funding since investors like these green bonds more than less focused ones.

Our fourth testable hypothesis descends from a simple conjecture. Namely, being supranational entities, the SNATs have a lower ability to monitor the efficacy of the green projects supported by the proceeds of the green bonds they have issued. Their monitoring, in fact, may be

jeopardized by their geographical distance and the information asymmetries between the supranational planner and the national government at the stage of the so called first-level "institutional design" when the projects to be financed are negotiated (followed by the second level phase of the selection of the concessionaire for the construction and operation of the infrastructure) (de Rus and Socorro, 2010). Therefore, investors might require higher returns as a compensation for less efficacy of SNATs' green bonds. However, an issuer's sector has been found to be a driver of yields in the early work on green bonds by Zerbib (2019) who detected that financials exhibit a higher *greenium*. Since the SNATs in our sample are almost entirely financials, this might counterbalance the previous effect. Expecting that the first effect should prevail, we thus hypothesize that:

H4. The green bonds issued by the SNATs suffer a higher (prospective) cost of funding vis-à-vis the comparable green bonds issued by Sovereigns or Local Governments.

Finally, we can envisage a further effect relating to the size of the green bond issue. Ceteris paribus, a larger issue size might deliver a higher *greenium* (Wang et al., 2019) – i.e., a lower cost of funding. In these cases, in fact, investors could accept a lower return vis-à-vis smaller-sized green bond issues where larger-sized issues grant two benefits stemming from more public information available on the issue and also owing to the fact that a larger issue more likely achieves its specified target. In particular, the former benefit might descend from the fact that larger-sized issues attract monitoring by more analysts (Marquardt and Wiedman, 2005) as well as more coverage by the rating agencies (Fabozzi et al., 2014). In line with this conjecture, there is evidence that larger sized corporate green bond issues trigger a reduction of information asymmetries (Zhang et al., 2021). Size has been proven as well to be positively correlated with the magnitude of the *greenium* for corporate green bonds (Caramichael and Rapp, 2024). However, the existence of these favorable effects of issue size has not yet been tested for public sector green bonds. This delivers another testable hypothesis:

H5. The green bonds having larger issues enjoy a lower (prospective) cost of funding vis-à-vis otherwise comparable green bonds, because investors suffer less asymmetry of information on these bonds.

3. Data, Variables, Methodology and Results

3.1 Data and Variables

To investigate the performance of green bonds issued by the three types of public sector entities (Supranational – SNATs, Sovereigns – SOVs, Local Governments – LGs), we conduct an empirical analysis. We will now present the data collection process and the variables used.

Following Flammer (2020), the population of public sector green bonds issued in the international capital markets between 2007 and 2024 was identified through Bloomberg's fixed-income database. More specifically, we used Bloomberg's green bond indicator (which detects whether a bond is labeled as green vis-a-vis ordinary bond) by restricting the retrieval to non-corporate fixed-income asset classes. Key data on market and bond features were then retrieved. The population comprises 2,107 green bond issues. However, we restricted our analysis to a sample of 279 issues completed between 2012 and 2024 for two main reasons. First, we needed that for each one of the included issues the prospectus – showing the allocation of the green bond proceeds – was available on the issuer's website. Otherwise, the lack of this information would make it impossible for us to investigate the determinants of choosing a general-goal vs local-goal. Second, the lack of data concerning yield-to-maturity and volatility would preclude our analysis of the determinants of the cost of funding. Therefore, our estimates are based on the sample of 279 public sector green bond issues, which represents about 13% of the population but the share is 85% in terms of issued amounts and 27% of the number of green bond issuers. Table 1 reports the comparative statistics of the population vs the sample of public sector green bonds used for the purpose of our empirical analysis. Namely, the upper panel presents the distribution of the issuers and of the issues for the entire population and for our sample of 279 public sector green bonds, while the other two panels extend the comparison to the issue size and the maturity of these green bonds.

To validate the use of this sample of 279 public sector green bonds in our econometric analysis, we have conducted a one sample *t*-test, to verify whether the sample mean differs from that of the entire population. We have tested the difference between the means for maturity and amount issued for our sample of 279 green bonds vs the population of 2,107. For both variables, the test leads to the non-rejection of the null hypothesis that there is no difference between the mean of our sample and the entire population (Table 2).

[INSERT TABLE 1, TABLE 2 AND TABLE 3 ABOUT HERE]

Table 3 reports the breakdown of the green bond issues by country and by types of public sector issuer. Obviously, SNAT issues can be assigned to no specific country. Regarding Local Governments and Sovereigns, we highlight that in some countries only Sovereigns issue green bonds:

Chile, Colombia, Egypt, Hong Kong, Indonesia, Ireland, and Poland.[1] On the contrary, in some other countries only Local Governments issue green bonds: Argentina, Australia, Brazil, Canada, Denmark, Finland, France, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Pakistan, South Korea, Spain, Sweden, and Switzerland. The largest amounts of green bonds issued by Local Governments come from Canada and the Netherlands, while the largest amount of green bonds issued by Sovereigns comes from Ireland.

Besides collecting financial data on public sector green bonds, we classify the destination of the 279 green bonds' proceeds across several classes of beneficiaries. To this end, we rely on the sectoral breakdown of the international private climate change investments used by the United Nations Conference on Trade and Development (UNCTAD) and on the list of eligible green projects' categories recognized by the Green Bond Principles (GBPs; ICMA, 2021). More specifically, the UNCTAD distinguishes the two macro-sectors of climate change mitigation and climate change adaptation, whereby the former includes renewable energy, energy efficiency/emission reduction and low-emission transport and the latter comprises water management and other adaptation. The GBPs provide a non-exhaustive list of categories including renewable energy, energy efficiency, clean transportation, eco-efficient/circular economy adapted products, production technologies and processes, pollution prevention and control (e.g., waste reduction and recycling), sustainable water management, green buildings. In line with the above, we classify the use of the 279 green bonds' proceeds across seven different classes of beneficiaries: 1. *Renewable Energy*; 2. *Electricity and Gas*; 3. *Energy Efficiency*; 4. *Transport*; 5. *Manufacturing*; 6. *Water and Waste Management*; 7. *Construction*. Then, we discriminate issues between general-goals (classes 1. and 2.) vs local-goals (classes from 3. to 7.). Data on the use of green bonds' proceeds across such classes were hand-collected on the basis of post-issuance reports periodically released by the issuers.[2]

This classification follows the idea that, vis-à-vis the others, the first two classes have broader green impact. To start with, 1. *Renewable Energy* is the first item both in the Green Bond Principles – GBP (ICMA, 2021) and in the Green Loan Principles – GLP (LMA-APLMA-LSTA, 2021)[3]. Second, classes 1. and 2. more actively contribute to abating CO2 emissions, addressing the strongest form of negative externalities relating to global warming. Third, both 1. *Renewable Energy* and 2. *Electricity and Gas* are amply validated in the literature as main GHG mitigators (Ritchie et al. 2020; Mazzacurati et al., 2021). Finally, referring to Europe – where European issues represent more than half of our sample (excluding SNATs which cannot be allocated geographically) – a comprehensive

[1] It should be noted that in very few cases prospectuses were used when post-issuance reports were missing.
[2] In very few cases prospectuses were used when post-issuance reports were missing.
[3] For both GBP proceeds and GLP proceeds the list of eligible projects for the destination of starts with: i) renewable energy – including production, transmission, appliances and products.

program was introduced to limit EU's dependence on fossil fuels (REPowerEU – European Commission, 2022). Indeed, the two strongest actions by REPowerEU consist in: i) accelerating the rollout of renewables (class 1.); ii) investing to create a resilient and interconnected EU energy infrastructure (class 2.).

On the contrary, proceeds going to the other five classes – from 3. to 7. – seem to target a weaker form of negative externalities relating to local environmental conditions, possibly assuaging local voters. Hence, local-goal green bonds may adhere to local electorates, whereas general-goal green bonds likely abide by the global constituency. In view of the importance of this differential green impact (or impact materiality), the classification of strategic goals of green bonds (*General-Goal*) is our first key dependent variable.

Coming to our explanatory variables, which are subdivided into three categories (Market, Bond, Issuer), to study whether the green impact (but this will also apply to the cost of funding) differs across the three categories of public sector issuers, we constructed three dummy variables: *SNAT*, *SOV*, *LG*. Next, we adopted the Herfindahl-Hirschman index (*HHI*) to measure the level of industry concentration of the green bond issues in relation to the use of their proceeds by the issuer across seven classes of beneficiaries. *HHI* is the focus of the individual green bond issues, i.e., the extent to which public sector issuers avoid dispersing green bonds' proceeds across several sectors. Notably, the HHI has been used extensively in the green finance literature to measure the degree of concentration of ESG-oriented infrastructure funds' portfolio investments (Baldi and Lambertides, 2024) and, more specifically, in green bond research to gauge the ownership base of green municipal bonds (Baker et al., 2022; Li et al., 2023) or the level of competition of a country's capital markets (Kim et al., 2025). To test whether some key events – such as the 2015 Paris Agreement, the UN Agenda 2030 on Sustainable Development Goals (SDGs) or the US President Trump's election in 2016 with his presidential mandate throughout the 2017-2020 period – may have influenced the destination of proceeds of green bonds by public sector entities, we constructed a time trend (*Time*) across the sample period (2012-2024).

Our second key dependent variable (addressing financial materiality) is the cost of funding of public sector green bond issues as measured by the secondary market (bid-ask spread) yield-to-maturity (*YTM_mid*) (Löffler et al., 2021). In this case, our independent variables – subdivided into three categories (Market, Bond, Issuer) – may be further subdivided into main- vs control-variables. The former include the three public sector dummy variables (*SNAT*, *SOV*, *LG*), *HHI* and the issued amount of green bonds (*Ln_Issue*) (Barua and Chiesa, 2019; Löffler et al., 2021; Caramichael and Rapp, 2024). This last variable is meant to verify whether investors reward a larger size of the underlying infrastructure project(s) financed by the green bond issue by accepting a lower return.

Among the control variables, we introduce volatility (*Vol_260*) (Gronwald and Wadud, 2025), the issuer's credit rating (*SP_Rating*) (Zerbib, 2019; Barua and Chiesa, 2019; Zhang et al., 2021; Caramichael and Rapp, 2024), maturity (*Maturity*) (Zhang et al., 2021; Caramichael and Rapp, 2024; Ruan et al., 2025), the use of an ESG metric (*ESG_Select*) (Flammer, 2021; Dutordoir et al., 2024; Feldhütter et al., 2024; Guesmi et al., 2025), four dummies for classes of beneficiaries (*Renew_En, En_Eff, Transport, WaterWaste_Mgmt*) (Sangiorgi and Schopohl, 2023), and five regional dummies (*Europe*, *North America*, *Latin America*, *Asia*, *Oceania*) controlling for heterogeneities stemming from geographical locations of public sector green bond issuers and, possibly, of currencies of issue (Gianfrate and Peri, 2019). We expect a higher cost of funding when volatility is larger, in the presence of a worse credit rating, and with shorter maturities because Quantitative Easing reversed the yield curve in the period of observation. On the opposite, we anticipate a lower cost of funding when *ESG_Select* is equal to 1 – i.e., the selection of the infrastructure project(s) to be financed using the proceeds of the green bond issue is ESG-driven.

Some additional variables are then introduced later, as detailed in commenting our robustness checks. In particular, we have two new dependent variables: *Mid-Goal* – which is a third intermediate realization of the strategic goal variable standing in between general-goals and local-goals, transforming our logit- into a multinomial-regression – and *Multi-Issuer* – a dummy variable accounting for frequent issuers. Separately, we have an additional independent control variable: the *Corruption Perceptions Index* (CPI),[4] where a higher level of perceived public sector corruption might raise the cost of funding.

Definitions and sources of all variables with indication of expected signs are summarized in Table 4 Panel A and the related descriptive statistics are reported in Table 4 Panel B.

[INSERT TABLE 4 PANELS A AND B ABOUT HERE]

In addition, Table 5 reports key descriptive statistics broken down by the three types of public issuers. The upper panel shows that three of the seven classes of beneficiaries attract 88.9% of the issues. In particular, Renewable Energy counts 89 (31.9%) of the 279 issues, Transport counts 84 (30.1%) and Construction counts 75 (26.9%). Another noteworthy feature is that LGs allocate 54 of their 125 issues (43.2%) to Construction, while SNATs allocate 62 of their 136 issues (45.6%) to

[4] Transparency International is an independent, non-governmental, not-for-profit organization working in over 100 countries to end the injustice of corruption. Its mission is to stop corruption and promote transparency, accountability and integrity at all levels and across all sectors of society. Transparency International has developed the Corruption Perceptions Index (CPI), through which it annually ranks 180 countries around the world by their perceived levels of public sector corruption. The scores are given on a scale of 0 (highly corrupt) to 100 (very clean: absence of corruption). Data on such scores are available between 2012 and 2021. Based on the most updated survey (CPI 2021), South Sudan has a score of 11 (ranked at the lowest level) and Denmark has a score of 88 (ranked at the highest level).

Renewable Energy and SOVs' bulk of issues goes to Transport (10 or 55.6%). The middle panel reveals that the average size of issue is lowest for LGs (0.44 billion), intermediate for SNATs (0.79) and largest for SOVs (1.23). Finally, the bottom panel shows that *HHI* reaches on average the highest value for LGs (0.643), noticeably higher than for SOVs (0.504) and SNATs (0.468).

[INSERT TABLE 5 ABOUT HERE]

3.2 Methodology

In our empirical analysis, we employ two econometric techniques: (a) logistic regression and (b) OLS multivariate regression.

First, we build a pooled logit model to analyze the determinants of the probability that a public sector entity may choose a general-goal when issuing a green bond.[5] In this sense, we follow the conventional practice of using a discrete and limited dependent variable model, where the probability of choosing a general-goal for any public sector green bond issuer is modelled as:

$$y_i = \mathbf{X_i}\beta' + \mu_i \qquad [1]$$

where:

$$y_i = \begin{cases} 1 & \text{if } y_i > 0, \text{ public sector green bond issuer } i \text{ chooses a general-goal} \\ 0 & \text{otherwise} \end{cases} \qquad [2]$$

$\mathbf{X_i}$ is the set of exogenous (independent) explanatory variables and the error term. The probability that a public sector green bond issuer i chooses a general-goal is thus measured as follows:

$$prob\,(y_i = 1) = \frac{\exp \mathbf{X_i}\beta'}{1 + \exp \mathbf{X_i}\beta'} \qquad [3]$$

More specifically, we estimate three distinct logit models (Model I.1, Model I.2, Model I.3) in order to explore the different effects that the three typologies of public sector green bond issuers may have on the probability of choosing to finance infrastructural investments targeting general-goals.

[5] We run an independently pooled cross-section regression in order to take cross-sectional and time series aspects into account.

From equation [3], the logit Model I.1 may be written in the following log-linear form:

$$\log\left(\frac{p}{1-p}\right) = \alpha_0 + \alpha_1 SNAT + \alpha_2 SOV + \alpha_3 HHI + \alpha_4 Time + u_i \quad [4]$$

where p is the probability that any public sector green bond issuer i utilizes its green bond proceeds to finance an infrastructure investment project associated with a general-goal.

The logit Model I.1 considers the *SNAT* dummy variable, the *SOV* dummy variable, the *HHI* variable and the *Time* variable. The logit Model I.2 replaces the *SNAT* dummy variable with the *LG* dummy variable (*LG*), while it confirms the *SOV* dummy variable and the *HHI* variable. The logit Model I.3 – compared to Model I.2 – confirms the *SOV* dummy variable, the *LG* dummy variable, the *HHI* variable and the *Time* variable. Additionally, the logit Model I.3 includes two interaction variables: *SOV* x *HHI* and *LG* x *HHI*. All three logit models are estimated by maximum likelihood.

Second, we want to explore the cost of issuing green bonds. To that end, we employ a multivariate regression model (Model II.1) estimated through the ordinary least squares (OLS) method and choose as the dependent variable of our OLS regression model the yield-to-maturity computed on the basis of the average market prices resulting from averaging out bid and ask quotes ("mid-YTM"). The OLS regression model – where *Africa* is the omitted benchmark dummy – may be formally expressed as follows:

$$\begin{aligned} YTM_mid_i = {} & \beta_0 + \beta_1 Vol_{260} + \beta_2 SP_Rating + \beta_3 Ln_Issue + \beta_4 Maturity + \beta_5 ESG_Select \\ & + \beta_6 Renew_En + \beta_7 En_Eff + \beta_8 Transport + \beta_9 WaterWaste_Mgmt \\ & + \beta_{10} HHI + \beta_{11} SNAT + \beta_{12} LG + \beta_{13} Europe + \beta_{14} North_America \\ & + \beta_{15} Latin_America + \beta_{16} Asia + \beta_{17} Oceania + \varepsilon_i \end{aligned} \quad [5]$$

Our findings based on the logit and OLS regression models are presented and discussed next.

3.3 Results and Discussion

The logit regression is run to estimate the determinants of the probability that a public sector entity may choose a general-goal when issuing a green bond and (*post* issuance) deciding which infrastructure projects the related financial proceeds should be allotted to. Allocation of green bond proceeds should be typically planned before issuance, communicated to potentially interested market investors and periodically reported to the financial community through the release of post-issuance

reports. The results of our three logit models (Model I.1, Model I.2 and Model I.3) are presented in the first three columns of Table 6.

[INSERT TABLE 6 ABOUT HERE]

The dummy variable associated with SNATs (*SNAT*) as green bond issuers has a positive and highly significant (at 1% level) coefficient in Model I.1. This result supports the idea that the destination of proceeds from Supranational green bond issues more likely targets investment projects associated with general-goals. This is in line with the view that SNATs – differently from Local Governments – respond more to the global constituency than to local electorates. Accordingly, SNATs' green bond proceeds tend to more actively contribute to abating CO2 emissions, thereby addressing the strongest form of negative externalities relating to global warming. This finding empirically validates *H1*.

The coefficient of the *SOV* dummy points to mixed findings. Albeit it has a negative sign in both Models I.1 and I.2 (with statistical significance at 1% level in Model I.2), it becomes positive (with no statistical significance) in Model I.3, which strengthens the notion that, in line with *H1*, only Supranational green bonds more likely support infrastructural investment projects associated with general-goals.

The previous findings are further corroborated by the evidence of Models I.2 and I.3, where the SNAT dummy variable is replaced by the *LG*'s one. The *LG* coefficient is negative and has a strong statistical significance (at 1% level), thus conveying the idea that green bonds issued by Local Governments are more likely to finance infrastructure investments associated with local-goals. Hence, *H1* is fully supported.

The coefficient of the *HHI* variable accounting for the *focus* of individual green bond issues has a positive sign and a strong statistical significance (at 1% level) across Models I.1 and I.2. This is fully supportive of our second hypothesis (*H2*) that, in order to pursue general-goals, public sector institutions should concentrate the use of proceeds from the issuance of their green bonds.

However, when we introduce the interaction term *LG* x *HHI* (Model I.3), we see that this new variable is strongly significant and positive while the role of *HHI* per se is blurred: it becomes negative (-1.821) but its significance drops. In any event, the net effect is strongly positive since the magnitude of the coefficient of *LG* x *HHI* greatly outweighs that of *HHI*. Indeed, the value of the coefficient of *LG* x *HHI* is equal to +6.431, this goes to counter the effect of *LG* whose coefficient is significant, negative and equal to -4.675. So, in the hypothetical case in which local government A has *HHI* = 0 while local government B has *HHI* = 1, the overall effect on the likelihood of pursuing general-goals for A is -4.675 while for B the effect is - 4.675 - 1.821 + 6.431 = -0.065, almost zero

with a drop of 98.6% in the absolute value of the effect. In other words, it is likely that when a local government can afford to have a more focused issue, this identifies a situation in which it enjoys a milder constraint from its local constituency. This finding suggests that having *focused* green bond issues is particularly important for addressing Local Government's issues towards general-goals or, at least, (partly) neutralizing the bias towards local-goals. This provides some support for *H2a*.

The *Time* variable accounts for the presence of a trend across the sample period (2012-2024) to test whether some key events – such as the 2015 Paris Agreement, the UN Agenda 2030 on Sustainable Development Goals (SDGs) or the US President Trump's election in 2016 with his presidential mandate throughout the 2017-2020 period – may have influenced the destination of proceeds of green bonds by public sector entities. As its coefficient is negative but not statistically significant across all models (Model I.1, Model I.2 and Model I.3), we can conclude that these pivotal events for policy-making about sustainable transition have not affected the pursuit of general vs. local goal use of proceeds.

The OLS regression sheds new light on the determinants of public sector green bonds' cost of funding. The results of our OLS regression model (Model II.1) are presented in the first column of Table 7.

[INSERT TABLE 7 ABOUT HERE]

The positive and strongly significant coefficient confirms that when *Volatility* of green bond prices in the secondary market increases investors holding green bonds require a higher return.

In line with conventional expectations, returns of green bonds and their assigned credit ratings are inversely related, implying that, as the rating of a green bond improves, its yield-to-maturity declines. The magnitude of the coefficient of the *SP_Rating* variable (- 1.21) underlines a relatively high, adverse impact of the credit rating on green bond returns.

Interestingly, the coefficient of the variable associated with the issued amount (*Ln_Issue*) is negative and strongly significant. This supports the notion that the (increasing) size of the underlying infrastructure project(s) financed by the green bond issue matters and is rewarded by investors who accept a lower return. Indeed, as discussed above, larger-sized issues provide benefits to investors. *H5* is thus strongly supported.

Maturity has a negative sign and is highly significant, thus providing empirical support for the presence of an inverted yield curve due to the effect of the Quantitative Easing program that central banks have carried out at length following the Global Financial Crisis of 2008-2009. This implies that the longer the maturity of the green bond, the lower the return required by investors.

The *ESG_Select* dummy is not statistically significant, thus suggesting no relevance to green bond returns.

The coefficient of the variable capturing the *focus* of individual green bond issues, calculated through *HHI*, is negative and strongly significant. This finding suggests that more *focused* green bonds issues require a lower cost of funding, enabling issuers to enjoy a higher *greenium*. Hence, investors reward issuers of green bonds, whose proceeds are predominantly or exclusively destined to finance single-sector infrastructures, by accepting to earn a lower return and thus reducing bond placing costs. The magnitude of the coefficient (- 1.44) underscores a relatively high, negative effect of more *focused* green bond issues on returns. This finding provides strong support for *H3*.

Interestingly, the coefficients of SNATs (*SNAT*) and Local Governments (*LG*) as green bond issuers are both positive and highly significant from a statistical standpoint, thus suggesting that SOV green bond issuers exercise a greater placing power with the result of pushing yields-to-maturity, and hence their cost of funding, downward. The reverse occurs for green bonds issued by SNATs and LGs, whose comparatively lower placing power amplifies their own issuing costs thus translating into higher returns for investors. More specifically, the reduced placing power of SNATs is associated with their lower ability to monitor the efficacy of the green projects the proceeds of their green bonds are destined to. This translates into a higher cost of funding. *H4* is thus strongly supported by our empirical analysis. Since the SNATs in our sample are almost entirely financials, this result seems to contradict what earlier found by Zerbib (2019) who reported a higher *greenium* for financial sector issuers. The reason why also LGs suffer a higher cost of funding (a lower *greenium*) may be related to the fact that compared to national governments they are occasional issuers, may release less structured information and may thus be penalized by a perception of higher risk.

Additional Results

Among sectorial dummy variables, the *Renewable Energy*, *Water and Waste Management* and *Energy Efficiency* regressors are positive and statistically significant (at 1%, 5% and 10% level respectively). This provides evidence that the underlying infrastructures are riskier implying a higher return on the related green bonds. The last sector variable (*Transport*) turns out insignificant.

Finally, our model controls for the regions of domicile of the issuers (*Europe*, *North America*, *Latin America*, *Asia*, *Oceania*). Among them, *Europe* and *Asia* are both statistically significant (at 5% level). On one hand, our findings provide empirical evidence suggesting that making a great number of infrastructure projects eligible for green financing may foster a negative selection bias when choosing the classes of destination for green bond proceeds ("market for lemons"). The higher riskiness of such "lemon" projects – more often financed by LGs in Europe but to some extent also

in Asia – likely requires higher yields-to-maturity from green bond investors. On the other hand, for Asia, the higher yield probably descends as well from the fact that some of the sovereign issuers have poor ratings, such as Indonesia (BBB).

4. Robustness Checks

To validate our findings, we have performed several robustness checks. First, we have extended our baseline logit model. Our logit results are validated by integrating Model I.1 of Table 6 with a variable associated with the issued amount (*Ln_Issue*), controlling for the size of the green bond issue and the underlying infrastructure project financed through the related proceeds. Moreover, the five regional dummy variables control for the issuers' domicile. The results of the logit regression robustness of Model I.1 "new" are shown in the last column of Table 6.

Our extended logit regression shows that the coefficient of *SNAT* is positive and strongly significant, thus confirming that these institutions are more likely to utilize their green bond proceeds to finance investment projects associated with general-goals (*H1*). The finding that *SOV* is negative (though statistically insignificant) corroborates the idea that national treasuries often end up mimicking the behavior of LGs by targeting projects with a local impact to satisfy local constituencies. This also provides further support for *H1*.

HHI is confirmed positive and strongly significant, reinforcing – along *H2* – the notion that institutions issuing green bonds to accomplish general-goals are more likely to concentrate the use of proceeds into fewer classes in the attempt to address stronger forms of negative externalities such as those related to global warming. It should be noted that the size of the green bond issue has no significant effect on the above results.

Finally, in our extended model we control for green bond issuers' region of domicile. *Asia* is negative and statistically significant, thus implying that green bond issuers there are more likely to disburse proceeds from green bond issues to finance investment projects with a local level impact. The other regional dummies are insignificant determinants of the probability of allocating green bond proceeds to general-goals.

Another robustness check consists in running a multinomial logit model (Models I.1a, I.2a, I.3a). In practice, we started from the awareness that *Energy Efficiency* – the class of beneficiaries previously attributed to local-goals, together with the last four classes (*Transport*, *Manufacturing*, *Water & Waste Management*, *Construction*) – might in reality be somewhere in between general- vs local-goals in terms of destination of the green bond proceeds. In this respect, Akpanke et al. (2024) find that while *Renewable Energy* beats by far *Energy Efficiency* in terms of minimizing the Ecological Footprint, yet also *Energy Efficiency* does reduce CO2 emissions. Hence, we kept the

general-goal classification as before – *Renewable Energy*, *Electricity & Gas* – but restricted the previous local-goal classification to include only *Transport*, *Manufacturing*, *Water & Waste Management*, and *Construction*, and classified *Energy Efficiency* as a standalone new intermediate class (*Mid-Goal*). Formally, the general-goal class was categorized as 2, the local-goal one was categorized as 0, while *Mid-Goal* was assigned 1.

Our estimates, reported in Table 8, take local-goals as the reference category and general-goals as the dependent category. Noteworthily, our hypotheses are confirmed by the results of the multinomial logit regression. In particular, in Model I.1a we find that targeting general-goals is more likely only for *SNAT*-issued green bonds (*H1*), for more focused issues – i.e., those having a higher *HHI* – (*H2*), and concentrating the destination of proceeds on fewer classes of beneficiaries also helps *LGs* lessen their propensity for local-goals (*H2a*).

[INSERT TABLE 8 ABOUT HERE]

Furthermore, we have addressed the problem of endogeneity that may affect the results on the determinants of public sector green bonds' cost of funding from our main OLS regression analysis. The variable associated with the issued amount (*Ln_Issue*) and related to *H5* might be endogenous due to the omitted variable bias. To deal with this potential bias, we have adopted an instrumental variables (IV) approach through a two-stage least squares (TSLS) by choosing to instrument *Ln_Issue* with two new regressors that may have an impact on the size of the green bond issuance required to finance a given infrastructure project: the perceived level of the public sector corruption and the protection of creditor rights in a country. The first instrument is the *Corruption Perceptions Index* (*CPI*), the score assigned since 2012 to 180 countries around the globe by Transparency International to assess the perceived levels of public sector corruption, which has the following scale: 0 (= highly corrupt; lowest level) – 100 (= very clean/absence of corruption; highest level). The *CPI* we use is that assigned in 2019.

The second instrument is *Creditor Rights* (*CR*), an index constructed by Djankov et al. (2007) – following the one previously developed by La Porta at al. (1997) – to measure four powers of secured lenders in bankruptcy: (1) whether there are restrictions, such as creditor consent or minimum dividends, for a debtor to file for reorganization; (2) whether secured creditors are able to seize their collateral after the petition for reorganization is approved, that is, whether there is no automatic stay or asset freeze imposed by the court; (3) whether secured creditors are paid first out of the proceeds of liquidating a bankrupt firm; (4) whether an administrator, and not management, is responsible for running the business during the reorganization. A score of one is assigned when a country's laws and

regulations provide each of these powers to secured lenders so that the *CR* index aggregates the scores and varies between 0 (poor creditor rights) and 4 (strong creditor rights). The *CR* index is constructed as of January for every year from 1978 to 2003 for 133 countries. We expect that both a low perceived level of public sector corruption and a strong protection of creditor rights create a favorable environment in a country enabling public sector entities to issue larger amounts of GREEN BONDs to finance infrastructure projects of larger size. Hence, both the *Corruption Perceptions Index* and the *Creditor Rights* index are expected to be positively related to the issued amount (*Ln_Issue*) and inversely related to the yield-to-maturity of the green bonds.

When implementing the instrumental variables (IV) approach via a TSLS, in the first-stage regression we have found that one instrument, *CPI*, is statistically significant (at 1% level), while the other instrument, *CR*, is not statistically significant. Additionally, the test of overidentifying restrictions indicates that our instruments are valid and the model is well specified (the p-value is 0.1885), but the test for weak instruments reveals that our instruments are weak as the F-statistic is 7.82834, below the rule of thumb of 10. However, we have also conducted the Durbin-Wu-Hausman (DWH) test to examine the endogeneity of the *Ln_Issue* variable and we have found that the null hypothesis (H_0) is accepted as the Robust score chi2 (1) has a p-value of 0.7087 and the Robust regression F (1, 260) has a p-value of 0.7194 (both p-values are above 0.05). This implies that the issued amount (*Ln_Issue*) variable is exogenous and a standard OLS regression analysis should be used in place of an IV analysis. Hence, it is confirmed that our OLS regression model of Table 7 (Model II.1) is valid.

As we can use our multivariate regression analysis, its robustness is further validated by integrating a reduced, more parsimonious OLS model (using fewer key variables) with the inclusion of the *Corruption Perceptions Index*. We may, in fact, think that a local issuer's capture by its local constituency is more likely when corruption is pervasive. To assess the effect of public sector corruption on the yields of green bonds, we retrieved the related scores by Transparency International for 180 (both advanced and poor) countries around the world: the *Corruption Perceptions Index* (*CPI*). Our reduced OLS model omits target sectors for the allocation of green bond issues' proceeds and regions of domicile of issuers. We employ two specifications: Model II.2, which includes the *CPI* along with the key variables from the main OLS model of the first column of Table 7; Model II.3, which also adds the year fixed effects (Table 7, columns 2 and 3). First, the F-test value of Model II.2 is above that of the baseline model (Model II.1) suggesting an improvement in the goodness of fit. Moreover, including year fixed effects (Model II.3) seems to improve the model fit for two reasons. First, the F-test value is above that of the baseline model (Model II.1). Second, and more

importantly, both the AIC and the BIC values decrease suggesting a better predictive performance and a lower risk of overfitting.

Our baseline OLS results are still confirmed. In particular, we further validate three of our hypotheses. First, in line with *H5*, greater sizes of green bond issues (*Ln_Issue*) enable public sector issuers to enjoy a lower cost of funding as investors are more prone to accept lower returns. Second, in line with *H3*, when green bonds' proceeds focus on fewer sectors (higher *HHI*) investors accept lower returns, which translates into a lower cost of funding. Third, also *H4* is additionally validated where, compared to *SOVs*, both *SNATs* – due to their lower ability of monitoring the efficacy of their target funding – and *LGs* – which less frequently place green bonds in the global markets and offer less structured information – undergo higher costs of green bond issuance.

CPI turns out highly significant and bears the expected negative sign – as higher values of the index associate with less corruption, with investors rewarding lower corruption by requiring a lower return. Moreover, also the interaction of *CPI* with S&P rating turns out significant implying that diverse corruption levels will have a different impact depending on the level of the rating of the issue.

In the last two columns of Table 7 we present the results of two additional robustness checks. In particular, Model II.4 re-specifies the base OLS model, using robust standard errors and adding country and year fixed effects (and dropping regional dummies). Compared to the baseline OLS model, the decrease of both the AIC and BIC values points to a superior fit of Model II.4, especially in terms of predictive performance and risk of overfitting. Overall, the evidence still supports *H5* – see the negative coefficient of *Ln_Issue* –, *H3* – see the negative coefficient of *HHI* –, and gives partial validation to *H4* – see the positive coefficient of *LG* and the lack of significance for *SNAT*.

Additionally, keeping country and year fixed effects, we verify whether our results are robust to an alternative estimation methodology which reduces the econometric problems due to errors in measure. For this purpose, we employ the quantile regression which performs the estimate on the ranks rather than on the numerical values (Model II.5). Compared to the baseline OLS model, the adjusted R2 increases from 0.585 to 0.682 suggesting a better fit of Model II.5. While confirming *H5* and *H3*, regarding *H4* the evidence loses significance for the *SNAT* effect, while *LGs* still pay higher yields.

Finally, we have also conducted a further robustness analysis which detects the presence of possible "experience effects" (Malmendier, 2021) and "phase effects" (Claessens et al., 2012). In this sense, we first estimate a new logistic regression (Model III), where p is the probability that any public sector entity i is a multi-issuer, having issued green bonds frequently and intensively, thus qualifying as an "experienced" issuer. To do so, we construct a dummy variable (*Multi-Issuer*), which takes the value of 1 if the entity has issued more than 6 green bonds (i.e., above the median) and 0

otherwise. The minimum number of issues is 1, the mean is 9.7 and the maximum is 28. Multi-issuing regards 138 of the 279 issues (49.5%). The independent, explanatory variables are *SNAT*, *HHI* and *Time*. Second, we re-estimate the reduced OLS model on a restricted sample of public sector green bonds restricted to year 2019 (including 70 bonds only) (Model II.6). The choice of restricting the sample to 2019 only is due to the fact that this year may help us capture important evolutions in investors' attitude towards the green bond market. Indeed, in some respects, 2018 seems to be a turning year possibly marking a "phase effect" for investors' interest in sustainable finance considering that BlackRock, the largest investment firm in the world, issued a statement in this sense.[6] This was a major turnaround from the previous attitude identifying the maximization of shareholder value as the sole purpose of the company.[7] Thus, this change in investors' attitude in favor of sustainable finance might exert important phase effects on the attractiveness of green bonds, and these effects might be visible exactly in 2019. In line with this, studying the green bond market over the years 2007-2019 Löffler et al. (2021) find evidence of the existence of a *greenium* in the secondary market only for 2018 and 2019, while Li et al. (2023) document a post-2018 *greenium* for U.S. municipal bonds. More recently, Caramichael and Rapp (2024) uncover that a significant *greenium* emerges only as of 2019, coinciding with the growth of the sustainable asset management industry following EU regulation. In turn, Hyun et al. (2023) show that in the global green bond market, for the years 2014-2019, (experienced) frequent issuers enjoy significantly lower cost of funding (114–177 basis points less on their bond issues relative to infrequent green bond issuers). This finding is particularly interesting for our analysis since it offers a potential bridge between "experience effects" and "phase effects".

Table 9 summarizes the results of this further robustness analysis. In particular, the new logit model (Model III) reveals that the probability of being a *Multi-Issuer* increases for *SNATs* and also that *Multi-Issuers* are more likely to have more highly focused issues (higher *HHI*). This result implies that *SNATs* qualify as experienced issuers – having been multi-issuers more frequently than other public sector institutions – and, thus, are natural candidates to pay lower yields to investors

[6] Fink (2018), the CEO, wrote in his letter to CEOs that "Society is demanding that companies, both public and private, serve a social purpose. To prosper over time, every company must not only deliver financial performance, but also show how it makes a positive contribution to society. Companies must benefit all of their stakeholders, including shareholders, employees, customers, and the communities in which they operate … a company's ability to manage environmental, social, and governance matters demonstrates the leadership and good governance that is so essential to sustainable growth, which is why we are increasingly integrating these issues into our investment process. Companies must ask themselves: What role do we play in the community? How are we managing our impact on the environment?".

[7] Since 2019, sustainable finance may also benefit from the modified stance of the Business Roundtable, which revised its Statement on the Purpose of a Corporation along a sustainability-friendly approach. This was a U-turn with respect to the previous view that a corporation should just focus on maximizing shareholder value. Harrison et al. (2019) explain that the free market view steadily took over since the 1970s, when Friedman (1970) stated that "the social responsibility of business is to increase its profits." Instead, along Freeman (1994) the legitimation of a company comes from serving its multiple stakeholders, not just its shareholders. This was labelled the "Friedman vs. Freeman Debate" and, clearly, in 2019 the Business Roundtable has opened up to Freeman, with ample ramifications favoring sustainable finance.

when the phase effect materializes. Indeed, the new reduced OLS model (Model II.6) shows that, on their issues of 2019, *SNATs* (and also *LGs*) have afforded a lower cost of funding. This instability of the OLS results opens up the possibility that the cost of funding by issuer type might reflect not only their relative ability to monitor the use of proceeds across projects and their relative placing power but also a phase effect. In fact, as we can appreciate from Figure A, for *SNATs* – but to some extent also for *LGs* – the distribution over the years of the issues is front-loaded, whereas it is back-loaded for the *SOVs*.[8] Since the *greenium* has probably increased over the years, these issuer types' higher cost of funding might partly be explained by the fact that the distribution of their issues was front-loaded. All in all, our findings seem to confirm that *SNATs* are experienced issuers and end up paying a lower cost of funding when investors' buoyant demand creates a favorable phase effect for green investments, as it materialized for the green bond market in 2019.

[INSERT TABLE 9 ABOUT HERE]

5. Conclusions

This paper addresses the legacy of the green bonds by public sector institutions, the related issuance strategies concerning the use of proceeds, and the associated cost of funding descending from the yield required by investors. Regarding the legacy, although green bonds were conceived by public sector entities, scholarly attention has been disproportionately attracted by corporate green bonds. Yet, public sector entities are still generating above one third of total green bond issues and may exercise a stewardship role in promoting green transition (Heine et al., 2019) as well as in expanding corporate issues while also improving market practices (Cheng et al., 2024). In this respect, we remedy the under-researched status of public sector green bonds. Besides describing the overall trends of the public sector green bond market across its three segments (Supranationals, Sovereigns, Local Governments – see Appendix), we contribute to its legacy by addressing how green bond performance differs across those three issuer segments. We measured performance in two innovative ways by: i) unveiling whether issuance strategies differ across issuer types, leading them to pursue general-goals rather than local-goals in the destination of the green bond proceeds, so broadening the green impact within the double materiality framework; ii) identifying which factors reduce the (prospective) cost of funding, where a lower yield in the secondary market implies that the issuer saves on interest expenses, referring to financial materiality.

[8] The share of green bonds issued in 2007-2018 over those issued in the entire period under study (2007-2024) stands, in fact, at 24% for SNATs, at 15% for LGs and at 10% only for SOVs.

From a methodological standpoint, our innovations required a painstaking hand collection of information on the destination of green bond proceeds whose details were hidden between the lines of post-issuance reports. These newly generated data were then coupled with indicators on market, issuer and bond features.

We employed both limited dependent variable- and OLS-regressions on the determinants, respectively, of choosing general-goals (issuance strategies), and of green bonds' secondary market yields (cost of funding). Specifically, in terms of strategies, we found that issues more likely target general-goals if they either come from Supranationals or have a more concentrated use of proceeds, where the latter also dampens Local Governments' bias towards local-goals. These results suggest that general-goals green bonds – responding to the global constituency and usually pursuing mitigation – are more likely chosen when either a distant issuer is detached from the local constituency (e.g., Supranational), or the issuer can afford concentrating the proceeds – thus favoring external monitoring –, something that for a near issuer (i.e., Local Government) is possible only if it is immune enough from that constituency's demands. Moreover, regarding the cost of funding, our evidence uncovers that, *ceteris paribus*, the yields on green bonds required by investors are higher when they are issued by Supranationals while they drop when the use of proceeds is more concentrated or the issue size is larger.

Overall, our study contributes to four strands of literature: 1) new knowledge on the under-researched public sector issues improves the extant research on green bonds; 2) our results add to the bond markets' literature by confirming that some of the regularities featured by green bonds in general (e.g., role of issue size and information asymmetries) also apply to the public sector segment; 3) the evidence we reach on impact vs financial materiality enlightens the common understanding of impact investing ; 4) our findings offer new insights on the political economy of green bond issuance, showing that political values (general vs local-goals) and political constraints (dependency on global vs local constituencies) shape issuance strategies.

Our results have policy implications for the fine tuning of green bond issuance strategies. Specifically, if they believe that pursuing general-goals is worthier than pursuing local-goals, then policy makers should increase the focus of their green bond issues and consider entrusting the issuance of green bonds to public entities which are more detached from local electorates, (e.g., choosing Supranationals vs Local Governments). In addition, structuring more focused green bond issues and/or enlarging the issue size would lower the cost of funding.

One limitation and two caveats need to be acknowledged. As to the former, although we can claim to have found a causality nexus going from a larger size of the issue to a lower cost of funding – where we could identify an appropriate instrumental variable for the size of the issue –, all of the

other links that we uncovered – for which an IV approach could not be operationalized – might not make it to the level of causal links. Nevertheless, we believe that even finding simple associations is instructive when investigating, as we did, topics not yet explored. Now on the caveats. First, our results come from a sample and, thus, might not generalize to the universe of public sector green bonds. Second, the vibrant growth of the market might imply that green bonds are undergoing changes in their nature, as also suggested by the introduction of new sustainable securities such as Sustainability (Linked) Bonds and Pandemic Bonds. If, indeed, the nature of green bonds is changing, then old issues would give limited guidance for new issues.

Our study may open new research avenues. An interesting topic regards the stewardship likely exerted by public sector green bonds. It might be worthwhile to investigate whether, at national level, public sector green bonds lead the expansion of corporate green bonds and/or bring benefits in terms of lower yields for corporate issuers (Flannery et al., 2023; Li, Magud and Werner, 2023). In addition, one could explore whether substitutability or complementarity prevails across green bond issues by SNATs, SOVs and LGs. Although past trends suggest complementarity – e.g., the rise of SOVs' green bond issues did not damage those by SNATs or LGs – the question is unsettled. Finally, it would be interesting to explore whether green bond issues lead to imitation by neighbors at three different levels. At domestic level, is there imitation across LGs? At regional level, is there imitation across SOVs? At global level, is there imitation across SNATs? Confirming evidence would indicate that green bond issues not only remove negative environmental externalities but may create positive externalities via imitation by other public sector issuers.

References

Ahmed, R., Yusuf, F., & Ishaque, M. (2024). Green bonds as a bridge to the UN sustainable development goals on environment: A climate change empirical investigation. *International Journal of Finance & Economics*, 29(2), pp. 2428-2451.

Akpanke, T. A., Deka, A., Ozdeser, H., & Seraj, M. (2024). Ecological footprint in the OECD countries: do energy efficiency and renewable energy matter?. *Environmental Science and Pollution Research*, *31*(10), pp. 15289-15301.

Allen, F., & Santomero, A. M. (2001). What do financial intermediaries do?. *Journal of Banking & Finance*. 25(2), pp. 271-294.

Arends, H. (2020). The dangers of fiscal decentralization and public service delivery: a review of arguments. *Politische Vierteljahresschrift*, 61(3), pp. 599-622.

Bachelet, M. J., Becchetti, L., & Manfredonia, S. (2019). The green bonds premium puzzle: The role of issuer characteristics and third-party verification. *Sustainability*, 11(4), 1098, pp. 1-22.

Baker, G. P. (1992). Beatrice: A study in the creation and destruction of value. *The Journal of Finance*, *47*(3), 1081-1119.

Baker, M., Bergstresser, D., Serafeim, G., & Wurgler, J. (2022). The pricing and ownership of US green bonds. *Annual Review of Financial Economics*. 14(1), pp. 415-437.

Baldi, F., & Lambertides, N. (2024). Exploring the role of ESG for the performance and risks of infrastructure investing: evidence from the international funds' market. *Managerial Finance*, *50*(1), pp. 92-117.

Baldi, F., & Pandimiglio, A. (2022). The role of ESG scoring and greenwashing risk in explaining the yields of green bonds: A conceptual framework and an econometric analysis. *Global Finance Journal*, *52*, 100711.

Barua, S., & Chiesa, M. (2019). Sustainable financing practices through green bonds: What affects the funding size?. *Business Strategy and the Environment*, 28(6), pp. 1131-1147.

Baulkaran, V. (2019). Stock market reaction to green bond issuance. *Journal of Asset Management*, 20(5), pp. 331-340.

Berensmann, K., Dafe, F., & Lindenberg, N. (2018). Demystifying green bonds. In *Research handbook of investing in the triple bottom line*. Edward Elgar Publishing.

Bouteska, A., Bhuiyan, F., Sharif, T., Miftah, B., & Abedin, M. Z. (2025). Impact of green bonds on traditional equity markets. *Research in International Business and Finance*, *73*, 102606.

Li, B., Wang, B., & Yu, J. (2023). The Emerging Greenium. *The Brookings Institution. Washington DC*.

Braga, J. P. (2020). The Green Bonds Market Performance and the Role of the Public Sector-Literature Review. Mimeo.

Caramichael, J., & Rapp, A. C. (2024). The green corporate bond issuance premium. *Journal of Banking & Finance*, *162*, 107126.

Chang, X., Hu, X., & Shen, R. (2024). Local Political Preferences and Green Municipal Bonds. *Available at SSRN 4973065*.

Chen, S. S. (2006). The economic impact of corporate capital expenditures: Focused firms versus diversified firms. *Journal of Financial and Quantitative Analysis*. 41(2), pp. 341-355.

Cheng, G., Ehlers, T., Packer, F., & Xiao, Y. (2024). Sovereign green bonds: a catalyst for sustainable debt market development?. *IMF Working Paper WP 24/120*.

Claessens, S., Kose, M. A., & Terrones, M. E. (2012). How do business and financial cycles interact?. *Journal of International Economics*, *87*(1), pp. 178-190.

Cunial, S. L. (2021). Transitions for whom? Political alignment and subsidies for solar energy projects in rural Colombian municipalities. *Latin American Policy*, 12(2), pp. 300-332.

Däubler, T. (2020). National policy for local reasons: how MPs represent party and geographical constituency through initiatives on social security. *Acta Politica*, 55(3), pp. 472-491.

Dell'Atti, S., Di Tommaso, C., & Pacelli, V. (2022). Sovereign Green Bond and Country Value and Risk: Evidence from European Union Countries. *Journal of International Financial Management & Accounting*, 33: 505–521.

de Rus, G., & Socorro, M.P. (2010). Infrastructure investment and incentives with supranational funding. *Journal Transition Studies Review*, 17, p.p. 551–567.

Djankov, S., McLiesh, C., & Shleifer, A. (2007). Private credit in 129 countries. *Journal of Financial Economics*, 84(2), pp. 299-329.

Doronzo, R., Siracusa, V., & Antonelli, S. (2021). Green bonds: The sovereign issuers' perspective. *Bank of Italy Markets, Infrastructures, Payment Systems Working Paper*, 3, 7–39.

Dutordoir, M., Li, S., & Neto, J. Q. F. (2024). Issuer motivations for corporate green bond offerings. *British Journal of Management*, *35*(2), pp. 952-973.

European Commission (2022). REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition.

European Commission (2019). The European Green Deal. COM (2019) 640, Brussels 11 December.

Fabozzi, F. J., Nawas, M., & Vink, D. (2014). Do multiple credit ratings signal complexity? Evidence from the European triple-A structured finance securities. (March 15, 2014).

Fama, E. F., & Jensen, M. C. (1983). Separation of ownership and control. *The Journal of Law and Economics*, *26*(2), pp. 301-325.

Fatica, S., & Panzica, R. (2021). Green bonds as a tool against climate change?. *Business Strategy and the Environment*, *30*(5), pp. 2688-2701.

Fatica, S., Panzica, R., & Rancan, M. (2021). The pricing of green bonds: are financial institutions special?. *Journal of Financial Stability*, *54*, 100873.

Feldhütter, P., Halskov, K., & Krebbers, A. (2024). Pricing of sustainability-linked bonds. *Journal of Financial Economics*, *162*, 103944.

Fink, L. (2018). *Larry fink's 2018 letter to CEOs. A sense of purpose*. Black Rock. Retrieved at: https://www.blackrock.com/corporate/investor-relations/2018-larry-fink-ceo-letter

Flammer, C. (2018). Competing for government procurement contracts: The role of corporate social responsibility. *Strategic Management Journal*, 39, pp. 1299–1324.

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

Flammer, C. (2021). Corporate green bonds. *Journal of Financial Economics*, 142(2), pp. 499-516.

Flammer, C., & Kacperczyk, A. (2016). The impact of stakeholder orientation on innovation: Evidence from a natural experiment. *Management Science*, 40, pp. 1982–2001.

Flannery, M. J., Hong, C. Y., & Wang, B. (2023). The effect of government reference bonds on corporate borrowing costs: evidence from a natural experiment. *Management Science*, *69*(7), pp. 4051-4077.

Freeman, R. E. (1994). The politics of stakeholder theory: Some future directions. *Business Ethics Quarterly* 4(4): pp. 409–421.

Friedman, M. (1970). The social responsibility of business is to increase its profits. *New York Times Magazine*, September 13.

Ghersi H., & Sabal J., (2006). Introduction to Project Finance in Emerging Markets. Estudio IESA N° 29. Retrieved on 13 January 2023 from http://servicios.iesa.edu.ve/Portal/EstudiosIESA/An%20introduction%20to%20project%20finance%20in%20emerging%20markets.pdf.

Gianfrate, G. Peri, M. (2019) The green advantage: Exploring the convenience of issuing green bonds. *Journal of Cleaner Production*, 219, pp. 127-135.

Glavas, D. (2018). How do Stock prices react to green bond issuance announcements?. Available at SSRN 3279069.

Goeminne S., & Smolders C. (2014). Politics and public infrastructure investments in local governments: Empirical evidence from Flemish municipalities (1996-2009). *Local Government Studies*. 40(2), pp. 182-202.

Goleman, D. (2013). The focused leader. *Harvard Business Review*. 91(12), pp. 50-60.

Gonschorek, G. J., Schulze, G. G., & Sjahrir, B.S. (2018). To the ones in need or the ones you need? The political economy of central discretionary grants− empirical evidence from Indonesia. *European Journal of Political Economy*, 54, pp. 240-260.

Gronwald, M., & Wadud, S. (2025). "My name is bond. Green bond." Informational efficiency of climate finance markets. *Journal of Environmental Management*, *373*, 123697.

Guesmi, K., Makrychoriti, P., & Pyrgiotakis, E. G. (2025). Climate change exposure and green bonds issuance. *Journal of International Money and Finance*, 103281.

Hachenberg, B., & Schiereck, D. (2018). Are green bonds priced differently from conventional bonds?. *Journal of Asset Management*, 19(6), pp. 371-383.

Hadlock, C., Ryngaert, M., and Thomas, S. (2001). Corporate structure and equity offerings: are there benefits to diversification?. *The Journal of Business*. 74, pp. 613– 635.

Harrison, J. S., Phillips, R. A., & Freeman, R.E. (2020). On the 2019 business roundtable "statement on the purpose of a corporation". *Journal of Management*, 46(7), pp. 1223-1237.

Heine, D., Semmler, W., Mazzucato, M., Braga, J. P., Gevorkyan, A., Hayde, E. K., & Radpour, S. (2019). Financing low-carbon transitions through carbon pricing and green bonds. *World Bank Policy Research Working Paper*, (8991).

Helwege, J., & Wang, L. (2021). Liquidity and price pressure in the corporate bond market: Evidence from mega-bonds. *Journal of Financial Intermediation*, 48, 100922.

Hyun, S., Park, D., & Tian, S. (2023). The price of frequent issuance: the value of information in the green bond market. *Economic Change and Restructuring*, *56*(5), pp. 3041-3063.

International Capital Markets Association (ICMA) (2021). Green Bond Principles. Voluntary Process Guidelines for Issuing Green Bonds.

Ivković, Z., Sialm, C., & Weisbenner, S. (2008). Portfolio concentration and the performance of individual investors. *Journal of Financial and Quantitative Analysis*, *43*(3), 613-655.

Kanamura, T. (2025). Stochastic behavior of green bond premiums. *International Review of Financial Analysis*, *97*, 103836.

Kapraun, J., Latino, C., Scheins, C., & Schlag, C. (2021). (In)-credibly green: Which bonds trade at a green bond premium?. Available at: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=3347337.

Karpf, A., & Mandel, A. (2018). The changing value of the 'green' label on the US municipal bond market. *Nature Climate Change*, 8 (2): 161-165.

Kim, S. S., Nugroho, V., & Handoko, L. (2025). Competitions among sub-financial sectors and growth of green bond markets in ASEAN plus three countries. *Managerial Finance*, *51*(1), pp. 166-184.

Kuchin, I., Baranovsky, G., Dranev, Y., & Chulok, A. (2019). Does green bonds placement create value for firms?. *Higher School of Economics Research Paper* No. WP BRP, 101.

Laeven, L., & Levine, R. (2007). Is there a diversification discount in financial conglomerates?. *Journal of Financial Economics*, 85(2), pp. 331-367.

Lang, L. H., & Stulz, R. M. (1994). Tobin's q, corporate diversification, and firm performance. *Journal of Political Economy*, *102*(6), pp. 1248-1280.

La Porta, R., Lopez-de-Silanes, F., Shleifer, A., & Vishny, R.W. (1997). Legal determinants of external finance. *The Journal of Finance*, 52(3), pp. 1131-1150.

Larcker, D. F. & Watts, E. M. (2020). Where's the greenium? *Journal of Accounting and Economics*, 69, pp. 1-26.

Li, D., Magud, N. E., & Werner, A. (2023). The long-run impact of sovereign yields on corporate yields in emerging markets. *Journal of International Money and Finance*, *130*, 102748.

Li, B., Wang, B., & Yu, J. (2023). The Emerging Greenium. *The Brookings Institution. Washington DC*.

Lin, B., & Su, T. (2022). Green bond vs conventional bond: Outline the rationale behind issuance choices in China. *International Review of Financial Analysis*, 81, 102063.

Loan Market Association, Asia Pacific Loan Market Association, Loan Syndications & Trading Association (LMA-APLMA-LSTA) (2021). *Green Loan Principles. Supporting environmentally sustainable economic activity*. 21 March.

Löffler, K.U., Petreski, A., & Stephan, A. (2021). Drivers of green bond issuance and new evidence on the "greenium". *Eurasian Economic Review*, 11(1), 1-24.

Malmendier, U. (2021). Experience effects in finance: Foundations, applications, and future directions. *Review of Finance*, *25*(5), pp. 1339-1363.

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

Marquardt, C., & Wiedman, C. (2005). Earnings management through transaction structuring: Contingent convertible debt and diluted earnings per share. *Journal of Accounting Research*, 43(2), pp. 205-243.

Mazzacurati, J., Paris, W., & Tsiotras, A. (2021). Environmental impact and liquidity of green bonds. *ESMA Report on Trends, Risks and Vulnerabilities*, (2).

Meo, M. S., Afshan, S., Zaied, Y. B., & Staniewski, M. (2025). The Resilience of Green Bonds During Market Turmoil: Implications for Investors and Policymakers. *International Journal of Finance & Economics*.

Mertzanis, C., & Tebourbi, I. (2024). National culture and green bond issuance around the world. *European Financial Management*, *30*(2), 879-934.

Mertzanis, C., & Tebourbi, I. (2025). Geopolitical risk and global green bond market growth. *European Financial Management*, *31*(1), 26-71.

Niczyporuk, H. (2020). Politics of Green Bonds Issuance. *NYU Stern School of Business Working Paper*.

Oman, W., Salin, M., & Svartzman, R. (2024). Three tales of central banking and financial supervision for the ecological transition. *Wiley Interdisciplinary Reviews: Climate Change*, 15(3), e876.

O'Sullivan, C., Papavassiliou, V. G., Wafula, R. W., & Boubaker, S. (2024). New insights into liquidity resiliency. *Journal of International Financial Markets, Institutions and Money*, 90, 101892.

Owen, E. (2019). Foreign direct investment and elections: the impact of greenfield FDI on incumbent party reelection in Brazil. *Comparative Political Studies*, 52(4), pp. 613-645.

https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131

Rajan, R., Servaes, H., & Zingales, L. (2000). The cost of diversity: The diversification discount and inefficient investment. *The Journal of Finance*, *55*(1), pp. 35-80.

Rehman, M. U., Zeitun, R., Vo, X. V., Ahmad, N., & Al-Faryan, M. A. S. (2023). Green bonds' connectedness with hedging and conditional diversification performance. *Journal of International Financial Markets, Institutions and Money*, 86, 101802.

Ritchie, H., Roser, M., & Rosado, P. (2020). CO_2 and greenhouse gas emissions. *Published online at OurWorldInData.org. Retrieved from: 'https://ourworldindata.org/co2-and-other-greenhouse-gas-emissions'*.

Rodríguez-Pose, A., & Gill, N. (2005). On the 'economic dividend' of devolution. *Regional Studies*, 39(4), pp. 405-420.

Ruan, Q., Li, C., Lv, D., & Wei, X. (2025). Going Green: Effect of green bond issuance on corporate debt financing costs. *The North American Journal of Economics and Finance*, *75*, 102299.

Russo A., Mariani, M., Caragnano. A. (2021). Exploring the determinants of green bond issuance: Going beyond the long-lasting debate on performance consequences. *Business Strategy and the Environment*. 30, pp. 38-59.

Sangiorgi, I., & Schopohl, L. (2023). Explaining green bond issuance using survey evidence: Beyond the greenium. *The British Accounting Review*, *55*(1), 101071.

Sartzetakis, E. S. (2020). Green bonds as an instrument to finance low carbon transition. *Economic Change and Restructuring*, pp. 1-25.

Shishlov, I., Morel, R., & Cochran, I. (2016). Beyond transparency: unlocking the full potential of green bonds. *Institute for Climate Economics*, pp. 1-28.

Siddique, M. A., Nobanee, H., Hasan, M. B., Uddin, G. S., & Nahiduzzaman, M. (2024). Is investing in green assets costlier? Green vs. non-green financial assets. *International Review of Economics & Finance*, 92, pp. 1460-1481.

Sojoudi, M., Bernard, C., Dupuy, P., & Peters, G. W. (2025). Green spread of US municipal bonds. *Annals of Operations Research*, pp. 1-27.

Stone Sweet A., & Sandholtz W. (1997). European integration and supranational governance. *Journal of European Public Policy*. 4:3, pp. 297-317.

Tang, D. Y., & Zhang, Y. (2020). Do shareholders benefit from green bonds?. *Journal of Corporate Finance*, 61, pp. 1-18.

Tanzi, V. (1996). Fiscal federalism and decentralization: a review of some efficiency and macroeconomic aspects. In *Annual World Bank Conference on Development Economics 1995*, 295–315. Washington D.C.: World Bank.

Thomas, S. (2002). Firm diversification and asymmetric information: evidence from analysts' forecasts and earnings announcements. *Journal of Financial Economics*. 64, pp. 373– 396.

Tuhkanen, H., & Vulturius, G. (2022). Are green bonds funding the transition? Investigating the link between companies' climate targets and green debt financing. *Journal of Sustainable Finance & Investment*, 12(4), pp. 1194-1216.

Turley, L., & Semple, A. (2013). *Financing sustainable public-private partnerships*. Winnipeg, MB, Canada: International Institute for Sustainable Development.

United Nations Conference on Trade and Development (UNCTAD) (2022). World Investment Report.

Wang, J., Chen, X., Li, X., Yu, J., & Zhong, R. (2020). The market reaction to green bond issuance: Evidence from China. *Pacific-Basin Finance Journal*, 60, 101294.

Wang, Q., Zhou, Y., Luo, L., & Ji, J. (2019). Research on the factors affecting the risk premium of China's green bond issuance. *Sustainability*, 11(22), 6394.

Wernerfelt, B., & Montgomery, C.A. (1988). Tobin's q and the importance of focus in firm performance. *The American Economic Review*. 78, pp. 246-250.

Wiśniewski, M., & Zieliński, J. (2019). Green bonds as an innovative sovereign financial instrument. *Ekonomia i Prawo. Economics and Law*, 18(1), pp. 83-96.

Yan, M., Li, X., Zhao, X., & He, Z. (2025). Liquidity and cost advantage of green bonds. *Finance Research Letters*, *71*, 106433.

Zerbib O.D. (2019). The effect of pro-environmental preferences on bond prices: Evidence from green bonds. *Journal of Banking and Finance*, 98, pp. 39-60.

Zhang, P., & Guo, Q. (2025). How do green municipal bonds affect carbon emissions in China? Evidence from the staggered difference-in-differences approach. *Journal of Environmental Management*, 373, 123692.

Zhang, R., Li, Y., & Liu, Y. (2021). Green bond issuance and corporate cost of capital. *Pacific-Basin Finance Journal*, *69*, 101626.

Table 1. Comparative Statistics of Population vs. Sample of Green Bonds

	Population (2,107 Issues)		**Sample (279 Issues)**	
Time Period of Issues	2007-2024		2012-2024	
Public Sector Green Bond Issuers (#):	234		63	
	# Issuers	# Issues	# Issuers	# Issues
SNATs	17	703	11	136
Sovereigns	46	1,187	7	18
Local Governments	171	117	45	125
	Total	Average	Total	Average
Issue Size (aggregate amount in billions of euro):	€ 219.50	€ 3.58	€ 185.53	€ 0.66
	Total	Average	Total	Average
SNATs	€ 73.857	€ 0.16	€ 108.68	€ 0.80
Sovereigns	€ 63.667	€ 3.18	€ 22.09	€ 1.23
Local Governments	€ 81.978	€ 0.24	€ 54.76	€0.44
Maturity (in years; mean)	9.6		9.1	

Source: Bloomberg

Table 2. One Sample *t*-Test on the Equality of Sample vs Population Means

	One Sample *t*-Test	
Variables >>>	Maturity	Amount Issued
N	279	279
Mean (Sample)	9.32	0.66
Mean (Population)	9.60	0.70
Mean Difference	–0.28	0.04
t	–1.35	–0.35
P-value (two-tailed)	0.18	0.72
H_0	Not Rejected	Not Rejected

Table 3. Distribution of Green Bond Issues by Country and by Type of Public Sector Issuer

	SNATs		**Sovereigns (*)**		**Local Governments (*)**	
Country	**Amount Issued (billions of euro)**	**#**	**Amount Issued (billions of euro)**	**#**	**Amount Issued (billions of euro)**	**#**
Argentina					0.49	2
Australia					2.80	4
Brazil					1.65	2
Canada					10.74	19
Chile			3.46	2		
Colombia			0.96	1		
Denmark					2.25	4
Egypt			0.64	1		
Finland					2.82	6
France					4.30	7
Germany					1.20	2
Hong Kong			3.88	5		
Indonesia			3.29	4		
Ireland			6.10	1		
Italy					0.50	1
Japan					2.73	14
Netherlands					7.12	13
New Zealand					0.20	2
Norway					2.61	7
Pakistan					0.41	1
Poland			3.75	4		
South Korea					5.57	13
Spain					1.50	3
Sweden					6.27	17
Switzerland					1.58	8
SNAT	108.68	136				
Total	**108.68**	**136**	**22.09**	**18**	**54.76**	**125**
Of which:						
Africa	*0.81*	*5*	*0.64*	*1*	-	-
North America	*7.47*	*43*	-	-	*10.74*	*19*
Latin America	*1.12*	*4*	*4.42*	*3*	*2.14*	*4*
Asia	*7.00*	*22*	*7.17*	*9*	*8.71*	*28*
Europe	*92.27*	*62*	*9.85*	*5*	*29.67*	*68*
Oceania	*0.00*	*0*	-	-	*3.00*	*6*

(*) By nature, each SNAT may be assigned to no specific country. The exclusive presence of either SOV or LG issues in a country descends from the combination of two facts: a) in most of the countries SOV and LG issues are not present together; b) in the remaining countries, the exclusion of one of the two issuer types was caused by the unavailability of the post-issuance reports.

Table 4. Descriptive Statistics

Panel A – Dataset

Variable - abbreviation	Description, unit of measure, sample	Expected Sign (OLS Model)	Expected Sign (Logit Model)	Source
	Dependent variables			
Return – YTM_mid	Yield to maturity of each green bond (GB), percentage, 2012-2024			Bloomberg
General-Goal – GG	General-Goal, dummy equal to 1 if top destination of proceeds is 1. Renewable Energy or 2. Electricity & Gas; 2012-2024			Authors' calculations on post-issuance reports
Mid-Goal	Categorical variable equal to 2 if top destination of proceeds is 1. Renewable Energy or 2. Electricity & Gas; 1 if top destination of proceeds is 3. Energy Efficiency; 0 if top destination of proceeds is 4. Transport; 5. Manufacturing; 6. Water and Waste Management; 7. Construction.			Authors' calculations on post-issuance reports
Multi-Issuer - MI	Dummy equal to 1 if the public sector entity has issued several GBs (above the sample median = 6)			Authors' calculations on Bloomberg
	Explanatory variables			
Volatility – Vol_260	260 day rolling volatility of each GB's market prices, percentage; 2012-2024	+		Bloomberg
Rating – SP_Rating	Rating issued by S&P on each GB, scale 1-8; 2012-2024	-		Bloomberg
Issue Size – Ln_issue	Issued amount of each GB, natural logarithm of billion euro; 2012-2024	-	+	Bloomberg
Maturity – Maturity	Maturity of each GB, in years; 2012-2024	-		Bloomberg
Focus – HHI	Herfindahl-Hirschman index measuring the level of the industry concentration of the GB issues in relation to the use of their proceeds by the issuer across 7 classes of beneficiaries (that is the focus of the individual GB issues); 2012-2024	-	+	Authors' calculations on Bloomberg
Supranational Entity Issuance – SNAT	Dummy equal to 1 if the GB was issued by a SNAT and 0 otherwise	+	+	Authors' calculations on Bloomberg
Local Government Issuance – LG	Dummy equal to 1 if the GB was issued by a Local Government such as municipal, province or regional entities and/or non-Treasury national agencies, 0 otherwise	+	-	Authors' calculations on Bloomberg
Sovereign Issuance –SOV	Dummy equal to 1 if the GB was issued by a Sovereign (national Treasury), 0 otherwise	-	+	Authors' calculations on Bloomberg
ESG Selection Project – ESG_Select	Dummy equal to 1 if the selected project to be financed through the GB issuance has been chosen applying an ESG metric, 0 otherwise	-		Authors' calculations on Bloomberg
Corruption Perceptions Index – CPI	Score developed by Transparency International to assess the perceived level of public sector corruption across countries; scale 0 (= highly corrupt; lowest level) - 100 (= very clean/absence of corruption; highest level); 2012-2024	-		Transparency International
Time Trend – Time	Years associated with each GB issue accounting for the impact of key political events on the use of the GBs' proceeds by the public sector entities across the sample period; 2012-2024		?	Bloomberg
Creditor Rights – CR	Index measuring four powers of secured lenders in bankruptcy across countries: (1) restrictions for a debtor to file for reorganization; (2) chance of collateral seizing for creditors; (3) use of proceeds from liquidation to pay creditors; (4) business run by an administrator (in place of management); a score of 1 is assigned when a country's laws provide each of these powers to secured lenders; range from 0 (poor creditor rights) to 4 (strong creditor rights); January 2003	-		Djankov, McLiesh and Shleifer (2007)
Europe	Dummy equal to 1 if the GB issuer is a SNAT, a Local Government or a Sovereign entity located in Europe, 0 otherwise	?	?	Authors' calculations on Bloomberg
North America	Dummy equal to 1 if the GB issuer is a SNAT, a Local Government or a Sovereign entity located in U.S.A or Canada, 0 otherwise	?	?	Authors' calculations on Bloomberg
Latin America	Dummy equal to 1 if the GB issuer is a SNAT, a Local Government or a Sovereign entity located in Latin America, 0 otherwise	?	?	Authors' calculations on Bloomberg
Asia	Dummy equal to 1 if the GB issuer is a SNAT, a Local Government or a Sovereign entity located in Asia, 0 otherwise	?	?	Authors' calculations on Bloomberg

Oceania	Dummy equal to 1 if the GB issuer is a SNAT, a Local Government or a Sovereign entity located in Oceania, 0 otherwise	?	?	Authors' calculations on Bloomberg
Renewable Energy – Ren_En	Dummy equal to 1 if the highest percentage of the proceeds of the single GB issue was used to finance projects in the renewable energy sector and 0 otherwise.	?		Authors' calculations on post-issuance reports
Energy Efficiency – En_Eff	Dummy equal to 1 if the highest percentage of the proceeds of the single GB issue was used to finance projects in the energy efficiency sector and 0 otherwise.	?		Authors' calculations on post-issuance reports
Transport	Dummy equal to 1 if the highest percentage of the proceeds of the single GB issue was used to finance projects in the transport sector and 0 otherwise.	?		Authors' calculations on post-issuance reports
Water and Waste Management – WatWaste_Mgmt	Dummy equal to 1 if the highest percentage of the proceeds of the single issue were used to finance projects in the water and waste management sector and 0 otherwise.	?		Authors' calculations on post-issuance reports

Table 4. Descriptive Statistics – continued

Panel B – Dependent and independent variables statistics

Variable name	Description – formula	No. obs.	Min.	Mean	Max.	St. Dev.
YTM_mid	Yield at maturity calculated on the basis of average prices between bid and ask quotations.	279	-0.72	1.78	32.86	3.53
Vol_260	The standard deviation of the prices referring to the market trades of the last 260 business days: $\sigma = \sqrt[2]{\frac{\sum(x_i - \mu)^2}{n-1}}$	279	0.19	4.13	43.29	4.85
SP_Rating	Official ratings assigned to green bonds by Standard & Poor's, converted into an increasing score ranging from 1, assigned to issues with worst rating (in our sample, D) to 8, assigned to issues with AAA rating	279	1	7.35	8	1.06
Ln_Issue	Natural logarithm of the issued amount of green bonds	279	13.68	19.41	23.64	1.47
Maturity	Maturity of the issue computed (in years) as difference between the day of its issuance and the day of its maturity.	279	3	9.32	75.53	7.64
HHI	The HHI measures the level of the industry concentration of the GB issues in relation to the use of their proceeds by the issuer across 7 classes of beneficiaries. $\sum {c_i}^2$ where c_i is the percentage of the issue used for project in the i-th class (with *i* which varies between 1 and 7).	279	0.20	0.55	1	0.25
Corruption Perceptions Index	Score assigned to countries by Transparency International to assess the perceived level of public sector corruption; scale 0 (= highly corrupt) - 100 (= very clean).	279	29.76	63.64	89	17.25
Creditor Rights	Aggregate score assigned to countries to verify the existence of four powers of secured lenders in bankruptcy: (1) restrictions for a debtor to file for reorganization; (2) chance of collateral seizing for creditors; (3) use of proceeds from liquidation to pay creditors; (4) business run by an administrator (in place of management); a score of 1 is assigned when a country's laws provide each of these four powers to secured lenders; range 0 (poor creditor rights) - 4 (strong creditor rights).	279	0.00	1.87	4.00	0.75

Table 5. Degree of Proceeds' Concentration Across Classes of Beneficiaries

	Number of Issues		
Issuer Type >>>	SNAT	Sovereign	Local Government
Class of Beneficiaries:			
Renewable Energy	62	0	27
Electricity & Gas	1	2	13
Energy Efficiency	5	0	2
Transport	48	10	26
Manufacturing	1	0	0
Water & Waste Management	2	2	3
Construction	17	4	54
TOTAL	*136*	*18*	*125*
	Average Issue Amount (€ bln)		
Issuer Type >>>	SNAT	Sovereign	Local Government
Class of Beneficiaries:			
Renewable Energy	0.37	0.00	0.56
Electricity & Gas	0.31	1.64	0.54
Energy Efficiency	11.30	0.00	0.40
Transport	0.44	15.85	0.51
Manufacturing	0.60	0.00	0.00
Water & Waste Management	0.51	1.59	0.50
Construction	0.36	2.98	0.32
MEAN VALUE	*0.79*	*1.23*	*0.44*
	Average HHI [0 ≤ HHI ≤ 1]		
Issuer Type >>>	SNAT	Sovereign	Local Government
Class of Beneficiaries:			
Renewable Energy	0.84		0.81
Electricity & Gas	0.53	0.52	0.91
Energy Efficiency	0.49		0.40
Transport	1.07	5.35	0.61
Manufacturing	0.63		0.00
Water & Waste Management	1.11	0.80	0.60
Construction	0.73	2.40	0.52
MEAN VALUE	*0.47*	*0.50*	*0.64*

Table 6. Logit Regression Results

This table shows the results of the main logistic regression analysis (Model I.1, Model I.2, Model I.3) of the determinants of the probability that a public sector entity may choose a general-goal (vs a local-goal) when issuing a green bond (GB). The dependent variable is *General-Goal*, which is a categorical variable equal to 1 if the destination of a public sector GB proceeds is 1. Renewable Energy or 2. Electricity & Gas, and 0 if the destination of the proceeds is 3. Energy Efficiency, 4. Transport, 5. Manufacturing, 6. Water and Waste Management, or 7. Construction. *SNAT* is a dummy variable equal to 1 if the issuer of the GB is a Supranational Entity and 0 otherwise. *SOV* is a dummy variable equal to 1 if the issuer of the GB is a Sovereign Entity – that is, a country's Treasury – and 0 otherwise. *LG* is a dummy variable equal to 1 if the issuer of the GB is a Local Government (e.g., municipality, province, region) and 0 otherwise. *HHI* is the Herfindahl-Hirschman index that measures the level of the industry concentration of the GB issues in relation to the use of their proceeds by the issuer across seven classes of beneficiaries, that is the focus of the individual GB issues. *SOV x HHI* (*LG x HHI*) is the interaction variable between *SOV* and *HHI* (*LG* and *HHI*). *Time* is a variable – ranging from 2012 to 2019 – indicating the year associated with each GB issue to account for the impact of key political events on the use of the GBs' proceeds by the public sector entities across the sample period. The last column of this table shows the results of the robustness check of Model I.1 new, associated with the logistic regression analysis (Model I.1). Model I.1 is integrated with a variable controlling for the size of the GB issue (*Ln_Issue*) and regional dummy variables controlling for the regions of domicile of public sector GB issuers. The dependent variable is *General-Goal*. *Ln_Issue* is the natural logarithm of the issued amount of each GB. *Europe* (*North America*, *Latin America*, *Asia*, *Oceania*) is a dummy variable equal to 1 if the GB issuer is a SNAT, LG or SOV entity located in Europe (U.S.A. or Canada, Latin America, Asia, Oceania), and 0 otherwise. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	Dependent Variable: General-Goal (GG)				
		Model I.1	**Model I.2**	**Model I.3**	**Model I.1 new**
Feature		Coefficient	Coefficient	Coefficient	Coefficient
Issuer	SNAT	0.874*** (0.285)			0.793*** (0.307)
Issuer	SOV	-1.143 (0.782)	-2.017*** (0.777)	0.052 (1.936)	-0.791 (0.839)
Issuer	LG		-0.874*** (0.285)	-4.675*** (0.845)	
Bond	HHI	1.390*** (0.537)	1.390*** (0.537)	-1.821** (0.900)	1.704*** (0.568)
Issuer x Bond	SOV x HHI			-5.335 (5.141)	
Issuer x Bond	LG x HHI			6.431*** (1.283)	
Market	Time	-0.004 (0.053)	-0.004 (0.053)	-0.029 (0.057)	
Bond	Ln_Issue				-0.096 (0.094)
Market / Issuer	Europe				-0.693 (0.660)
Market / Issuer	North_America				0.106 (0.698)
Market / Issuer	Latin_America				-0.257 (0.938)
Market / Issuer	Asia				-1.499** (0.717)
	Oceania				-0.454 (1.109)

Market / Issuer					
	Constant	5.735 (107.984)	6.610 (107.970)	59.742 (114.842)	-0.675 (1.958)
	Cox & Snell R2	0.067	0.067	0.174	0.122
	Nagelkerke R2	0.091	0.091	0.237	0.167
	Loglikelihood	350.168	350.168	316.253	333.155
	N° of Observations	279	279	279	279

Table 7. OLS Regression Results

The first column of this table shows the results of the first main regression model, estimated through the multivariate OLS method (Model II.1), aimed at detecting the determinants of the cost of funding for public sector GB issuers. The dependent variable is the *Yield-to-Maturity (YTM_mid)*, which is the secondary market yield-to-maturity of a GB calculated on the basis of average prices between bid and ask quotations (expressed in %). *Vol_260* is the standard deviation of the prices referring to the market trades of the last 260 business days (expressed in %). *SP_Rating* is the official rating assigned to each GB by Standard & Poor's, converted into an increasing score ranging from 1, assigned to issue with worst rating (D), to 8, assigned to issue with best rating (AAA). *Maturity* is the life span of each GB until its expiration, computed as the difference between the day of its issuance and the day of its maturity (expressed in years). *ESG_Select* is a dummy variable equal to 1 if the selected project to be financed through the GB issue has been chosen applying an ESG metric, and 0 otherwise. *Renew_En* (*En_Eff*, *Transport*, *WaterWaste_Mgmt*) is a dummy variable equal to 1 if the highest percentage of the proceeds of the single GB issue was used to finance projects in the renewable energy (energy efficiency, transport, water and waste management) sector and 0 otherwise. For *Ln_Issue*, *HHI*, *SNAT*, *LG*, and the regional dummies (*Europe*, *North America*, *Latin America*, *Asia*, *Oceania*) please refer to Table 6. The second and third columns display the results of a reduced (more parsimonious) OLS model as a further robustness check of the main OLS regression analysis. This reduced OLS model omits target sectors for the allocation of GB issues' proceeds and regions of domicile of public sector GB issuers. Two specifications are employed: Model II.2, which includes the *Corruption Perceptions Index* (*CPI*) along with the key variables from the main OLS model; Model II.3, which, besides including the key variables from the main OLS model, adds the year fixed effects. *Corruption Perceptions Index* is the score developed by Transparency International to assess the perceived level of public sector corruption in the countries of the public sector GB issuers of our sample along the 2012-2019 period; scale 0 (= highly corrupt) - 100 (= very clean/absence of corruption). *Corruption Perceptions Index x SP_Rating* is the interaction variable between *CPI* and *SP_Rating*. The fourth and fifth columns present the results of two additional robustness checks of the main OLS regression analysis. In Model II.4 the base OLS model is re-specified by adding country and year fixed effects and removing the regional dummies. Model II.4 is estimated with robust standard errors. Model II.5 applies the quantile regression in order to reproduce the base OLS model. The quantile regression analysis is applied to a restricted OLS base model, where the regional dummy variables are omitted. (Robust) Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	Dependent Variable: Yield-To-Maturity (YTM_mid)	**OLS**	**OLS**	**OLS**	**OLS**	**Quantile**
		Model II.1	**Model II.2**	**Model II.3**	**Model II.4**	**Model II.5**
Feature		Coefficient	Coefficient	Coefficient	Coefficient	Coefficient
Market	Vol_260	0.428*** (0.040)	0.399*** (0.040)	0.386*** (0.034)	0.190** (0.085)	0.150*** (0.018)
Bond	SP_Rating	-1.211*** (0.200)	-3.038*** (0.463)	-3.143*** (0.393)	-0.543** (0.226)	-0.342** (0.161)
Bond	Ln_Issue	-0.455*** (0.110)	-0.398*** (0.105)	-0.510*** (0.089)	-0.458*** (0.078)	-0.257*** (0.042)
Bond	Maturity	-0.140*** (0.023)	-0.126*** (0.024)	-0.118*** (0.021)	-0.051 (0.040)	-0.033*** (0.010)
Issuer	ESG_Select	-0.206 (0.666)	-0.121 (0.651)	-0.787 (0.587)	-0.728 (1.192)	0.298 (0.280)
Bond	Renew_En	2.133*** (0.422)			0.862*** (0.206)	0.625*** (0.183)
Bond	En_Eff	1.742* (1.013)			0.412 (0.452)	0.607 (0.402)
Bond	Transport	0.675 (0.425)			0.180 (0.200)	0.170 (0.182)
Bond	WaterWaste_Mgmt	1.443** (0.603)			0.215 (0.219)	0.139 (0.299)
Bond	HHI	-1.444*** (0.557)	-0.819 (0.541)	-1.432*** (0.454)	-1.635*** (0.472)	-0.770*** (0.276)

Issuer	SNAT	1.229* (0.726)	1.392** (0.711)	1.031* (0.606)	0.000 (0.623)	0.302 (0.515)
Issuer	LG	1.312** (0.645)	1.510** (0.646)	0.945 (0.542)	22.474*** (2.719)	25.575*** (1.243)
Market / Issuer	Europe	1.589** (0.717)				
Market / Issuer	North America	0.553 (0.784)				
Market / Issuer	Latin America	1.737 (1.075)				
Market / Issuer	Asia	1.570** (0.748)				
Market / Issuer	Oceania	-0.426 (1.212)				
Market	Corruption Perceptions Index		-0.304*** (0.064)	-0.300*** (0.053)		
Market x Bond	Corruption Perceptions Index x SP Rating		0.038*** (0.008)	0.039*** (0.007)		
	Constant	16.085*** (2.636)	31.898 (4.224)	27.335 (3.804)	13.605*** (2.448)	7.546*** (1.442)
	Country Fixed Effects	No	No	No	Yes	No
	Year Fixed Effects	No	No	Yes	Yes	No
	Adj R2	0.585	0.569	0.713	0.868	0.683
	Model F	24.010***	37.730***	32.430***	.	.
	AIC	1268.764		1169.959	961.794	.
	BIC	1334.126		1253.477	1110.674	.
	N° of Observations	279	279	279	279	279

Table 8. Robustness Analysis: Multinomial Logit Regression

This table shows the results of the multinomial logit regression serving as a robustness check associated with the main logistic regression analysis. The multinomial logit regression consists of three models (Model I.1a, Model I.2a, Model I.3a). The dependent variable is categorical: the general-goal class of beneficiaries of a GB issue's proceeds (1. *Renewable Energy*, 2. *Electricity & Gas*) is categorized as 2; the local-goal class (4. *Transport*, 5. *Manufacturing*, 6. *Water and Waste Management*, 7. *Construction*) is categorized as 0; the intermediate class (between general and local-goals) (3. *Energy Efficiency*) is categorized as 1 (this category is named as *Mid-Goal*). The estimates are performed taking the local-goal class of beneficiaries as the reference category and the general-goal class as the dependent category. All other variables have been already defined in Table 6. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

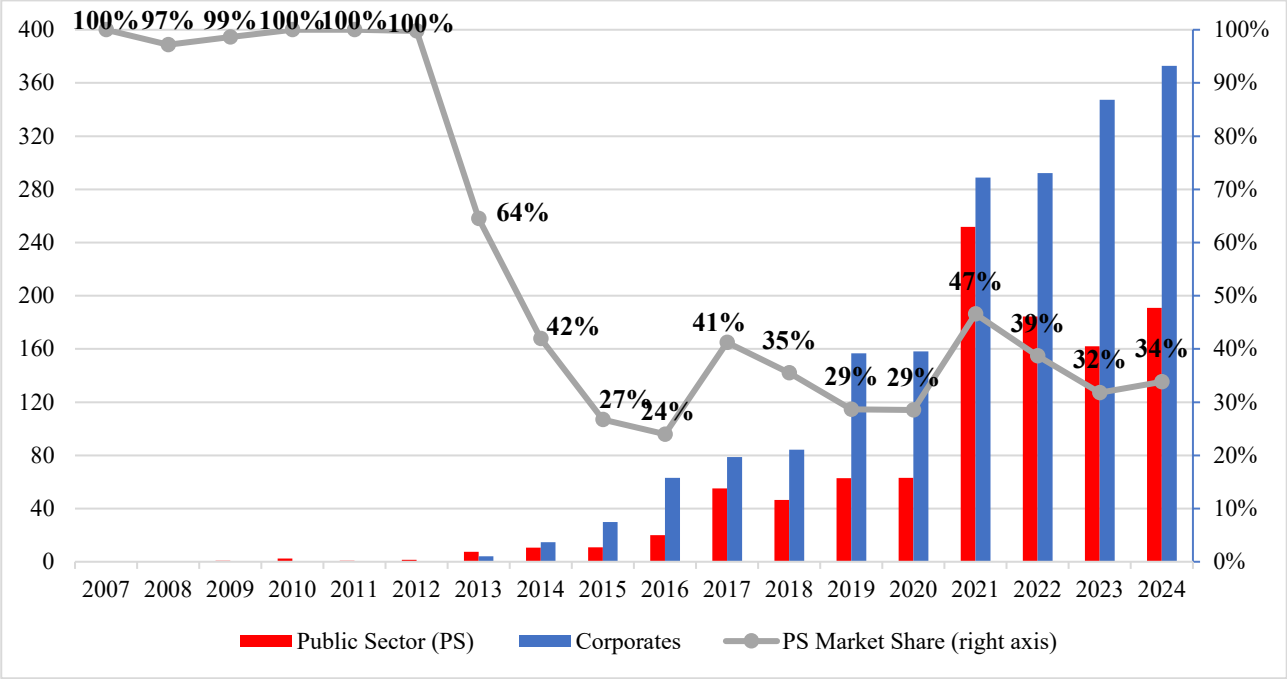
	Dependent Variable (Y): Renewable Energy, Electricity & Gas (2) Energy Efficiency (1) (Mid-Goal) Transport, Manufacturing, Water & Waste Management, Construction (0)			
	Category Chosen as a Reference = 0			
		Model I.1a (Y=2)	**Model I.2a (Y=2)**	**Model I.3a (Y=2)**
Feature		Coefficient	Coefficient	Coefficient
Issuer	SNAT	0.896*** (0.287)		
Issuer	SOV	-1.184 (0.782)	-2.081*** (0.777)	-0.197 (1.940)
Issuer	LG		-0.896*** (0.287)	-4.878*** (0.856)
Bond	HHI	1.261** (0.542)	1.261** (0.542)	-2.179** (0.928)
Issuer x Bond	SOV x HHI			-4.989 (5.136)
Issuer x Bond	LG x HHI			6.738*** (1.302)
Market	Time	0.007 (0.054)	0.007 (0.054)	-0.015 (0.058)
	Constant	-15.287 (109.279)	-14.390 (109.264)	31.986 (116.782)
	Cox & Snell R2	0.098	0.098	0.208
	Nagelkerke R2	0.125	0.125	0.265
	Loglikelihood	377.354***	377.354***	341.118***
	N° of Observations	279	279	279

Table 9. Robustness Analysis of Experience and Phase Effects

This table presents the results of a last robustness analysis on the presence of "experience" and "phase" effects. The analysis consists of two models: Model III and Model II.6. Model III is a logistic regression aimed at detecting the determinants of the probability that any public sector entity is a multi-issuer. The dependent variable is *Multi-Issuer*, which captures the experience effect of a frequent GB issuer. It is defined as a dummy variable equal to 1 if the public sector entity has issued a number of GBs above 6 (sample median) and 0 otherwise. All the other variables have been defined in Table 6. Model II.6 is a reduced version of the OLS base model estimated on a restricted sample of public sector GBs only limited to 2019 (including 70 bonds) to capture important evolutions in investors' attitude towards the GB market (phase effect). The dependent variable is the *Yield-to-Maturity (YTM_mid)*, which has already been defined in Table 7. All the other variables have been defined either in Table 6 or in Table 7. Standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

Dependent Variable: Multi-Issuer (MI)		*Dependent Variable*: Yield-To-Maturity (YTM_mid)	
	Logit Model		**OLS Model**
	Model III		**Model II.6**
	Coefficient		Coefficient
SNAT	4.312*** (0.497)		
HHI	4.110*** (0.866)		
Time	0.077 (0.068)		
Constant	-159.101 (136.766)		
		Vol_260	0.177*** (0.039)
		SP_Rating	0.253 (0.543)
		Ln_Issue	-0.423*** (0.070)
		Maturity	-0.075*** (0.023)
		ESG_Select	0.938* (0.500)
		HHI	-0.842* (0.466)
		SNAT	-0.993* (0.529)
		LG	-0.891** (0.430)
		Corruption Perceptions Index	0.025 (0.062)
		Corruption Perceptions Index x SP_Rating	-0.004 (0.008)
		Constant	7.533* (4.347)
Cox & Snell R2	0.425	Year Fixed Effects	No
Nagelkerke R2	0.567	Adj R2	0.447
Loglikelihood	232.178	Model F	6.576***
N° of Observations	279		70

Figure 1. Distribution of Green Bond Issues Among Corporate and Public Sector Entities (2007-2024)



Source: Bloomberg

APPENDIX

The Contribution of Public Sector Issuers to the Green Bond Market

The transition towards a low-carbon society (i.e., global warming within 2°C and strongly curbed greenhouse gas (GHG) emissions) requires allocating significant financial resources to eco-friendly investments. To channel savings to such investments, the use of innovative financing instruments, such as green bonds, has been recommended at academic (Berensmann et al., 2018; Gianfrate and Peri, 2019; Maltais and Nykvist, 2020), political (European Commission, *European Green Deal*, 2019; OECD, 2016; 2017) and central banking levels (Sartzetakis, 2019; Lagarde, 2020).

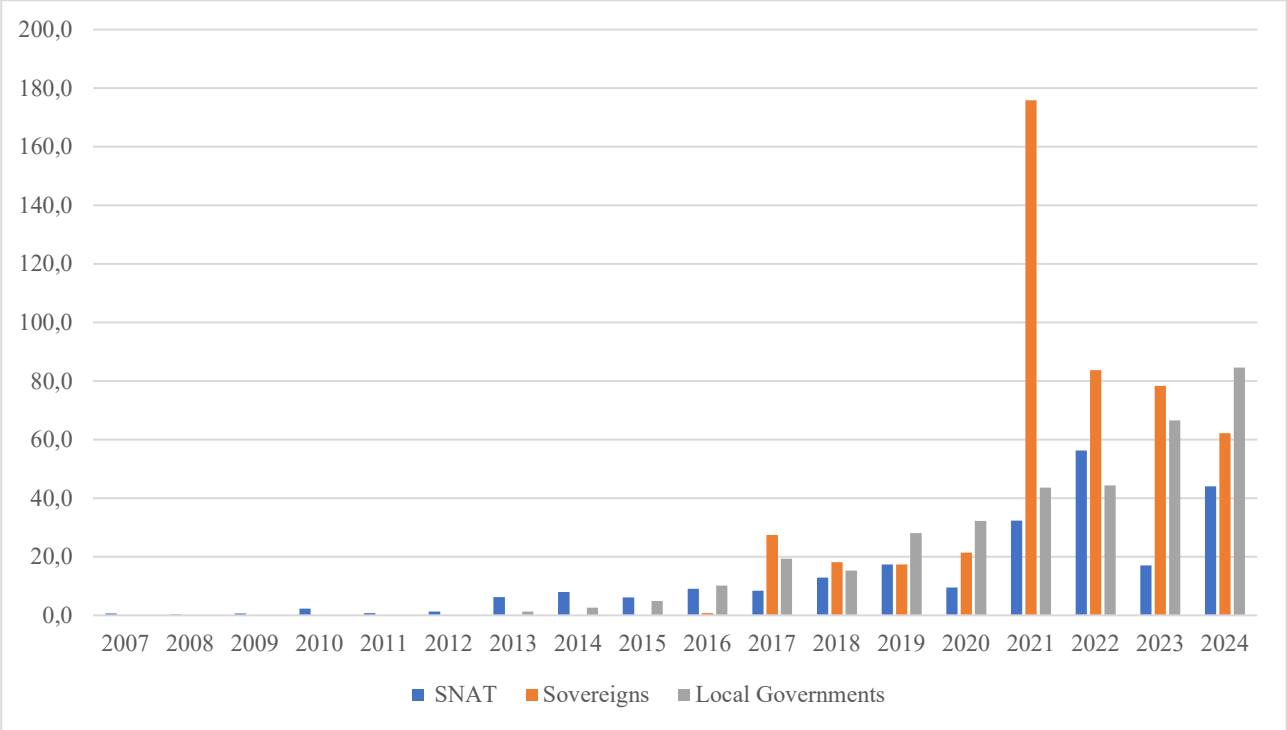
Green bonds belong to a new asset class that in the past years experienced a remarkable growth in demand from responsible investors and supply from various types of issuers operating both in the private (corporates) and public sector (Sovereigns – SOV, Local Governments – LG, Supranational entities – SNAT, including multilateral development banks). Specifically, green bonds are debt securities whose proceeds exclusively go to partly or completely finance or re-finance new and/or existing eligible eco-friendly investment projects following, since 2014, the Green Bond Principles (GBPs). These are industry self-regulations promoted by issuers, investors and intermediaries to avoid self-labelling and establish reporting requirements for green bonds. Along with the GBPs, projects eligible for green bond financing include, among others, renewable energy, energy efficiency, pollution reduction, water and waste management (ICMA, 2021; Maltais and Nykvist, 2020). The green bond market unleashed manifold benefits to both issuers and investors. Issuers can (a) better communicate their sustainability strategy to the financial community, (b) create internal synergies between financial and sustainability departments, (c) lower the cost of capital to finance or re-finance green projects and (d) broaden their investor base. In turn, by adopting ESG investment policies, investors can develop more informed investment strategies while also decarbonizing their portfolios and complying to new regulations (Shishlov et al., 2016; Gianfrate and Peri, 2019). Demand for green bonds is also upheld by national regulations: e.g., in France energy transition laws force investors to report their climate-related risk exposure, while requirements by Bank of England and the Securities and Exchange Board of India foster the development of the green bond market.

The first green bond – "Climate Awareness Bond" – was issued in 2007 by a public sector entity, the European Investment Bank (EIB). Thereafter, especially after the release of the GBPs and of similar certification frameworks in other jurisdictions (e.g., China, India), the green bond market has grown rapidly, diversified issuers and unfolded a dedicated ecosystem of actors (e.g., credit rating agencies, second party opinion providers). After their local peak of 2021 (€ 540.7 billion), green bond new issues dropped to € 476.5 billion in 2022 but rebounded to a new tip (€ 563.8 billion) in 2024.

By type of issuers, the green bond market was de facto monopolized by the public sector until 2012 (Figure 1). Then, corporate issuers rapidly gained momentum, downsizing the market share on new green bond issues by public sector issuers to the yet historical minimum of 24% in 2016. Subsequently, however, with the entry of SOVs and the doubling of LGs, the public sector market share of green bonds rebounded to 41% in 2017. Further oscillations materialized henceforth but the public sector market share of green bonds still stood at 34% in 2024.

Within public sector issues, SNATs were the virtually the sole protagonists until 2012 (Figure A). Thereafter, issues by LGs grew progressively, to the point that these issues represented 44% of the total (SNAT issues accounting for 56%) by 2015. Then, since 2016, the boom of SOV issues changed the picture. By 2021, SOV issues counted for 70% of total public sector green bond issues, leaving 17% to LGs and only 13% to SNATs. But subsequently there was a rebalancing and, by 2024, LG green bond issues represented 44% of the total, followed by SOVs (33%) and SNATs (23%).

Figure A. Amounts of Green Bond Issues per Category of Public Sector Issuers (2007-2024; € billion)



Source: Bloomberg