PUBLIC SECTOR GREEN BONDS.
WHAT DRIVES PROCEEDS' INVESTMENTS AND PERFORMANCE?

Francesco Baldi

Department of Management, University of Turin (Italy)

Department of Economics and Finance, LUISS Guido Carli University (Italy)

Email: francesco.baldi@unito.it, fbaldi@luiss.it

Giovanni Ferri

LUMSA University of Rome (Italy)

Email: g.ferri@lumsa.it

The research assistance provided by Cristina Maria Romano (CASMEF, LUISS Guido Carli University) and Giovanni Russo is gratefully acknowledged.

Public Sector Green Bonds: What Drives Proceeds' Investments and Performance?

Abstract

Green Bonds (GBs) are essential to accelerate the sustainable transition. A buoyant literature studies corporate GB issues, which now prevail. However, GBs were initially issued by public sector entities, who still cover almost one third of the market, and may exercise a stewardship in promoting the sustainable transition. To remedy their under-researched status, our comprehensive work focuses on public sector GBs, issued by Supranational, Sovereign, and Local Government institutions. Besides describing the overall trends, we investigate whether strategic motivations behind the issuance of GBs and performance differ across the three categories of public sector issuers on a sample of GBs. We collect key financial data and classify the destination of GBs' proceeds across seven different purposes: 1. Renewable Energy; 2. Electricity and Gas; 3. Energy Efficiency; 4. Transport; 5. Manufacturing; 6. Water and Waste Management; 7. Construction. Next, we distinguish issuances between general- (1. and 2.) vs local-interest (from 3. to 7.) purposes, and calculate their focus through an Herfindahl-Hirschman index. This distinction stems from considering that, while all of the purposes give a contribution, the first two purposes may have a more general impact on the sustainable transition, whereas the other purposes may give a local payoff. Finally, we estimate Logit and OLS regressions on the determinants, respectively, of choosing a general-interest purpose, and of GBs' cost-of-funding. Our salient findings include: i) more focused issuances more likely target general-interest purposes and lower the cost-of-funding; ii) Supranational issues more likely target general-interest purposes, but imply higher cost-of-funding; iii) a more concentrated destination of proceeds, leading to more focused issuances, enables Local Governments to switch their strategic financing target towards general interest projects. Our results have policy implications for the fine tuning of GB issuance strategies.

JEL Codes: G15; H23; H73; Q56.

Keywords: Green Bonds; Public Sector Entities; Local vs General Interest; Performance; Financing Sustainable Transition.

1. Introduction

The transition towards a low-carbon society (where global warming is limited to 2°C and greenhouse gas emissions are strongly reduced) requires significant investment of financial resources in ecologically sustainable development. To channel savings into sectors and projects that support such transition, the use of innovative financing instruments, such as green bonds (GBs), 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 are 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 (PS) (Sovereigns, Local Governments, Supranational entities, named as SNATs, including multilateral development banks). More specifically, green bonds are debt securities whose proceeds are exclusively used to partly or completely finance or re-finance new and/or existing eligible environment-friendly investment projects (Green Bond Principles – GBPs, ICMA, 2021).[1] The green bond market has proved to unlock a number of benefits to both issuers and investors. GB issuers are helped to (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. GB investors adopting ESG investment policies are offered the opportunity to develop more informed investment strategies while also expanding investment alternatives to decarbonize their portfolios and complying with new regulations (Shishlov et al., 2016; Gianfrate and Peri, 2019).[2]

The first green bond was issued in 2007 by a public sector institution, the European Investment Bank (EIB), and was labeled "Climate Awareness Bond". Since then, and especially with the publication in 2014 of voluntary standardized rules (GBPs) and similar certification frameworks in other jurisdictions (e.g., China, India), the market for green bonds has grown rapidly leading to a diversification of issuers and unfolding a dedicated ecosystem of actors (e.g., credit rating agencies, second party opinion providers). Green bond issuances have reached a total amount of about € 872.3 billion in year 2020 (3.5% of the overall bond market compared to 1% in 2016). In 2020, there was a total number of 886 new issuances (with an increase of about 94% on the 456 GBs issued in 2017).

In terms of types of issuers, despite the prevailing market share of corporates (68%; € 589.7 billion), the rest of the outstanding GB market (32%) has been issued by the public sector in the 2007-2020 period (Local Governments, 14%, € 107.4 billion; Sovereigns, 10%, € 80.8 billion; SNATs, 8%, € 62.7 billion). Public sector GB issuances have been steadily growing in recent years and spread across all types of institutions and geographic regions. More specifically, in 2020 Local Governments

[1] GBPs are industry self-regulations promoted by issuers, investors and intermediaries in the green bond market to avoid self-labelling and establish reporting requirements. According to the GBPs, eligible projects that can be financed with a green bond issuance include, among others, renewable energy, energy efficiency, pollution reduction, water and waste management (ICMA, 2021; Maltais and Nykvist, 2020).

[2] Demand for GBs is also being sustained by national regulations. For example, in France the energy transition law forces investors to report on how they are managing climate-related risks. Bank of England and the Securities and Exchange Board of India have issued requirements to foster the development of the GB market.

(e.g., municipalities, provinces) issued GBs for € 32.2 billion (14.5% of the total market), Sovereign (States) GBs touched € 21.4 billion (9.7%) and SNAT's GBs issuances totaled € 9.5 billion (4.3%).

Following the GB market increase, there has been a corresponding surge in the academic literature on this type of debt instruments. However, the bulk of research has focused on corporate green bonds investigating: 1) their convenience and pricing in the primary and secondary market versus conventional bonds (Gianfrate and Peri, 2019); 2) the ex post environmental performance of issuers and the credible signaling of their commitment toward the environment (Flammer, 2021); 3) the abnormal announcement returns (Glavas, 2018; Baulkaran, 2019; Kuchin et al., 2019; Wang et al., 2020; Flammer, 2021); 4) the overall positive spillover effects to shareholders (Tang and Zhang, 2020), and 5) the existence of a "green premium" (Hachenberg and Schiereck, 2018; Bachelet et al., 2019; Zerbib, 2019). Little is still known instead on GBs issued by public sector entities. Hence, our study aims at filling this gap in the literature.

Specifically, we distinguish public sector GBs according to whether they are issued by Supranational (SNATs), Sovereign (SOVs), or Local Government (LGs) institutions. Figure 1 displays the patterns in GBs' issuances by PS entities and private corporations, while Figure 2 provides more details on the overall trends of public sector GBs. The overall trend shows that public sector GBs were the almost exclusive character in the initial phase from 2007 (when the EIB issued its Climate Awareness Bond) until 2012, with the overall market share – ranging from 97% to 100% – being in the hands of SNATs and total volumes of issuances amounting to € 5.9 billion. The only exceptions were small-sized GB issuances by Local Governments (about € 0.1 billion) in the 2010-2012 period. Thereafter, the buoyant issuances of corporate GBs dented the share of PS GB issues, forcing it down from 100% in 2012 to 24% in 2016. More specifically, in 2013 the GB market share of PS entities declined to 64% (€ 7.6 billion) due to the arrival of corporate issuers, despite the expansion of Local Governments' issuances. In the 2014-2016 period, the GB market share of PS entities further dropped sharply to a low level of 24% (€ 19.9 billion) due to the steady growth of corporate issuances (CAGR of 63%; € 63.2 billion in 2016), despite the relative increase in the volumes issued by both SNATs and (especially) Local Governments. Indeed, since 2013, Local Governments' issuances increased steadily representing now half of the public GB market.

The public sector share of GB issues rebounded to 41% (€ 55.2 billion) in 2017, with the inception of sovereign GBs in 2016 with the first Sovereign GB placed by the Poland's Treasury[3],

[3] The first Sovereign GB issued by the Poland's Treasury was followed by other issuances in 2018 and 2019. Proceeds (€ 1 billion) from the GB sovereign issuance of 2018 were allocated by the Polish government to finance clean transportation projects (e.g., modernization of railway infrastructures) and sustainable agricultural operations (e.g., organic farming).

but entered a new declining phase to reach 29% in 2019 due to the expansion of corporate GBs.[4] The value stood constant at 29% in 2020, suggesting that PS issues were resilient to the COVID-19 shock.[5] Hence, corporate GBs now prevail but GBs issued by public institutions still represent almost one third of the market totaling € 63.2 billion.[6]

[INSERT FIGURES 1 AND 2 ABOUT HERE]

At regional level, it should be noted that LGs in France (30.9%, € 33.13 billion), Canada (10.6%, € 11.42 billion) and Sweden (10.3%, € 11.05 billion) were the most active issuers of GBs.[7] Among the SNATs, the most active GB issuer was the EIB (43%; € 26.96 billion)[8], followed by the Asian Development Bank (ADB) (10.9%; € 6.33 billion)[9] and the European Bank for Reconstruction and Development (EBRD) (9.9%; € 6.21 billion). The largest amount of sovereign GBs was issued by France (33.9%; € 27.37 billion), Germany (14.2%; € 11.50 billion) and the Netherlands (11.1%; €

[4] In the two subsequent years (2018-2019), PS bodies experienced a further decline in their GB market share from 35% to 29% due to the remarkable increase in corporate GB issuances reaching almost € 157 billion in 2019. Nonetheless, the volumes of GB issuances by SNATs and LGs continued to grow relatively across the overall 2015-2019 period.

[5] Most recently, in 2020, the growth of corporate green bonds' issuances, which reached more than € 158 billion, took a break in response to the outbreak of COVID-19. In this context, PS GBs stabilized their 29% market share thus showing a certain degree of resilience to the COVID-19 shock compared to corporate ones as their downward trend halted in the midst of the pandemic.

[6] In 2013-2015, as SNATs' GB issuances climbed reaching a peak of € 8 billion in 2014, LGs' ones started rising steadily with such a regular increase culminating in 2020 with a total issued amount of € 32.2 billion (51% of total market; CAGR of 49.6% in 2013-2020). In 2016, Poland issued the first national government GB opening up Sovereigns' side of the GB market. In 2017, Sovereign GB issuances boomed reaching the all-time peak of € 27.4 billion. Since then, there were ever-growing volumes of Sovereign GBs so as to represent one third of the PS GB segment in 2020 (€ 21.4 billion). The remainder of the segment (15%) is in the hands of SNATs that, after experiencing a steady growth (CAGR of 27.2%) in the 2017-2019 period, issued € 9.5 billion worth GBs in 2020.

[7] For instance, the City of Vancouver in Canada issued a € 55 million worth GB in 2018 aimed at financing sustainable water and wastewater management reconstruction programs, or the Province of La Rioja (central-western Argentina), launched two GB issuances amounting to € 500 million in 2017, using such proceeds to mainly finance the development of the Arauco Wind Farm and other public work projects (e.g., powerline constructions, solar farms).

[8] Since 2007, the EIB launched several other GB issuances aimed at financially supporting sustainable projects across Europe. For instance, the proceeds from the issuance of a € 1.75 billion worth GB in 2019 were allocated by EIB to finance, among others: the purchase of rolling stock in Austria (€ 75 million), France (€ 85 million) and Netherlands (€ 100 million), the modernization of railway in Poland (€ 400 million), the construction of off-shore wind farms in Belgium (€ 53 million) and energy efficient housing in Germany (€ 10 million).

[9] Since its GB program was launched in 2015, the ADB raised € 6.3 billion used to alleviate the adverse effects of the recent unrivaled economic growth on the environment of the Asia and Pacific region and promote its strategic priorities on climate change, inclusiveness and sustainability. Proceeds from outstanding GB issuances (denominated in various currencies) were disbursed to finance transport (67.9%) and renewable energy infrastructures (23.4%), such as the installation of a 150 MW wind farm in the Philippines (Burgos project). For example, in October 2019, ADB issued a euro-denominated GB worth € 750 million and its first-ever GB denominated in Norwegian kroner (NKr 1 billion).

8.99 billion).[10] All public GB case studies[11] mentioned in this paragraph are included in the sample of GBs used for our empirical analysis discussed hereinafter.

From a geographical standpoint, the overall trends of GB issuances can be analyzed looking at six macro-regions: North America, Latina America, Europe, Africa, Asia, Oceania (Figure 3). In North America, SNATs placed € 20.3 billion worth GBs (58%) and LGs € 14.5 billion worth GBs (42%), while no issues of GBs by Sovereigns were recorded.[12] In Latin America, all three typologies of PS issuers entered the GB market with Sovereigns prevailing with € 5.3 billion (57%), followed by LGs with € 2.5 billion (27%) and SNATs with € 1.5 billion (16%). In Europe, LGs' GB issuances amounted to € 71 billion (38%) overcoming those of Sovereigns (€ 66.2 billion; 35%) and SNATs (€ 51 billion; 27%). Hence, Latin America is similar (on smaller terms) to Europe as regards the heterogeneity of public sector issuers, with Sovereigns prevailing over the rest of entities in Latin America and volumes of LGs' issuances being (slightly) greater than those of Sovereigns and SNATs in Europe. SNATs were the leaders of the Asian GB market with € 34.3 billion (57%), followed by Local Governments with € 20.2 billion (34%) and Sovereigns with € 5.1 billion (9%).[13]

[INSERT FIGURE 3 ABOUT HERE]

To the best of our knowledge, our work is the first comprehensive study on public sector GBs. In this respect, we respond to the Russo et al. (2021)'s call for further research work on the determinants of the performance of GBs issued by Supranational, Sovereign or Local Government entities, with specific regard to the nature of projects financed through GB issuances. This article makes at least two valuable contributions to the literature. First, a growing body of research has investigated corporate GBs, but one third of the market, represented by public sector GBs, has so far escaped the attention of researchers with a few exceptions concerning municipal bonds (Karpf and

[10] Sovereign issuances of GBs are expected to increase to enable national governments to fulfill climate change requirements. For example, in 2021 the Italian Treasury made its inaugural GB issuance with the launch of a 24-year green BTP ("Buono del Tesoro Poliennale") aimed at attracting "impact investors" who do not yet hold Italian government debt. The Italian Treasury GB program, amounting to € 35 billion, is compliant with the GBPs (with the related framework certified through a second party opinion) and devoted to finance investments targeting 7 SDGs: SDG 6 (clean water), SDG 7 (affordable and clean energy), SDG 11 (sustainable cities and communities), SDG 12 (responsible consumption and production), SDG 13 (climate action), SDG 14 (life below water), SDG 15 (life on land).

[11] With the exception of the Italian BTP.

[12] In this study, we classify SNATs regionally according to the residence of their headquarters, even though the proceeds from their GB issuances can be allocated outside the region of headquarter residence. Thus, the World Bank Group – International Bank for Reconstruction and Development and International Finance Corporation – is allocated to North America, while the European Investment Bank and the European Bank for Reconstruction and Development are allocated to Europe, etc..

[13] In Africa, GB issuances were significantly smaller compared to the other regions, with SNATs having placed an overall amount of € 2.6 billion (65%), Sovereigns € 1.3 billion (32%) and Local Governments € 0.1 billion (3%). In Oceania, the domestic GB market was dominated by Local Governments with issuances worth € 5 billion (99%) and the remainder being issued by Sovereigns (€ 0.4 billion; 1%).

Mandel, 2018; Baker et al., 2021). Our study fills this gap. Second, our main contribution consists in studying whether strategic motivations behind GB issuances and their performance differ across the three categories of public sector issuers – Supranational, Sovereign, or Local Government entities. In particular, we measure performance in terms of the ability of a specific GB to better achieve the overarching goal of abating CO2 emissions (a social objective) and/or to pay investors a lower return (an issuer's objective). Our analysis exploits a sample of 199 GBs for which we could collect key financial data from Bloomberg. Based on the hand-collection of periodic post-issuance reports, we classify the destination of the 199 GBs' proceeds across seven different purposes (1. Renewable Energy; 2. Electricity and Gas; 3. Energy Efficiency; 4. Transport; 5. Manufacturing; 6. Water and Waste Management; 7. Construction) and discriminate issuances between general-interest (purposes 1. and 2.) vs local-interest (purposes from 3. to 7.). This classification follows the idea that the first two purposes bear more general consequences as they more actively contribute to abating CO2 emissions, thereby addressing the strongest form of negative externalities relating to global warming, while the proceeds destined to the other five purposes (3-7) target a weaker form of negative externalities relating to local environmental conditions, possibly assuaging local voters. Hence, local-interest GBs adhere to local electorates, whereas general-interest GBs abide by the global constituency. In addition, we calculate the focus of individual issuances through an Herfindahl-Hirschman index (HHI) measuring the extent of concentration of the proceeds across the seven purposes of the GB proceeds.

Estimating the determinants, respectively, of choosing a general-interest purpose – via Logit regressions –, and of GBs' cost-of-funding – via OLS regressions – we reach various findings, among which we may stress three salient results. First, more *focused* issuances more likely target general-interest purposes and afford a lower cost-of-funding. Second, Supranational issuances more likely target general-interest purposes, but imply higher cost-of-funding. Third, a more concentrated destination of proceeds, leading to more *focused* issuances, enables Local Governments to switch their strategic financing target towards general interest projects.

In the rest of the paper, Section 2 contains a concise 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, outline our methodology, and present and discuss the three salient results accompanied by additional main results. Section 4 presents the robustness analysis conducted to corroborate our empirical results. Section 5 recapitulates the main thrust of our work, draws the chief policy conclusions and provides suggestions for future research.

2. Literature Review and Hypotheses' Development

In the wake of the rapid growth of GB issuing in global capital markets since 2016, research has mainly sought to explain the stock market reaction to issuances of corporate GBs and their potential spillover effects to the stocks of the issuers. Most of these articles are very recent and all share the use of the Event Study methodology which leads to the estimation of Cumulative Abnormal Returns (CARs). Baulkaran (2019) studies the stock market reaction to the announcement of GB issuance. The CARs are positive and significant. But, GBs with higher coupon rates elicit a negative investor reaction. Also, firm size, Tobin's Q, and growth are positively related to CARs, while operating cash flow is negatively related to CARs. Flammer (2021) finds that the issuance of corporate GBs yields: i) positive CARs, ii) improvements in long-term value and operating performance, iii) improvements in environmental performance, iv) increases in green innovations, and v) an increase in ownership by long-term and green investors. Glavas (2018) finds a positive CARs after GB issuance. Besides, the CARs grew after the Paris Agreement. Kuchin et al. (2019) show the significance of GB issuance on positive CARs. Tang and Zhang (2020) study the announcement returns of GBs by corporations in 28 countries during 2007-2017. CARs are positive after GB issuance. Moreover, stock liquidity improves upon the issuance of GBs. Wang et al. (2020), studying the case in China, find a pricing premium of corporate GBs vs conventional bonds. The economic magnitude of the Chinese green bond pricing premium is greatly larger than that of an international green bond documented in prior studies. The pricing premium of corporate GBs is most pronounced for new issues from high corporate social responsibility (CSR) issuers and underwriters. It is also stronger for corporate issuers with less ownership concentration and held by long-term institutional investors. Further analysis reveals positive announcement stock returns for new issues of GBs, consistent with the stakeholder value maximization theory that corporate engagement in sustainable financing practice increases firm value in a long run and thus is favored by shareholders. Overall, all above researchers find positive CARs on stocks of corporate issuers following a GB issuance.

Other studies have tried to inquire into the performance of corporate GBs detecting the existence or not of a so called "green premium" (or "greenium"). Based on a sample of 89 bond couples, Bachelet et al. (2019) find that GBs have higher yields, are more liquid and less volatile than their closest brown bond correspondents. More specifically, institutional GBs display a negative premium, whereas private GBs have a positive premium unless the private issuer commits to certify the "greenness" of the bond. Overall, GBs may enjoy a negative premium and thus green investments may be financed at a discount. Hachenberg and Schiereck (2018) provide evidence that GBs on average do not trade significantly tighter than their counterparts. Zerbib (2019)'s study reveals that

the yield of a GB is lower than that of a conventional bond (- 2 basis points), thus implying a (small) negative premium, which is more pronounced for financial and low-rated bonds.

As said, only few academic works have addressed public sector GBs. Among them, Braga (2020) performs a survey of the literature on public sector GBs suggesting 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 GBs is understudied. Regarding municipal bonds, Karpf and Mandel (2018) uncover that green issuances 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, Larcker and Watts (2019) fail to detect a *greenium*. In turn, Wiśniewski and Zieliński (2019) advocate the issuance of sovereign GBs as the easiest way to attract investors and potentially increase issuance size which can contribute to lower the costs of financing green public tasks. On their part, Heine et al. (2019) argue that public sector GBs may exert a stewardship in terms of accelerating the sustainable transition, especially if those issuances are coupled with active carbon pricing policies. Specifically, they argue that the issuance of GBs 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.

An aspect deserving further attention lies in the possible differences in the strategic motivations driving the different types of public sector entities when deciding to issue a GB in the market. The first important distinction is – within a country – differentiating between SNATs (SNAT GBs) and Central Government (Sovereign GBs) on one hand vs Local Government (Municipal GBs) 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 (Däubler, 2020; Gonschorek et al., 2018; Owen, 2019). Moving from fiscal devolution to the green transition, by analyzing the 2015 Colombian mayoral elections, 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 reasoning to the theme of our paper, we may hypothesize that the strategic motivation behind the issuance of GBs by Local Governments could differ from the one behind the issuance of GBs by SNATs. On one hand, we might expect the SNATs – being unconstrained from local constituencies – to be able to pursue issuances that are both more concentrated on general-interest purposes and more focused on fewer purposes. This leads us to expect that GBs issued by the SNATs will be characterized by a higher value of the HHI. 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 issuances which are more devoted to local-interest purposes and perhaps also more dispersed across purposes in the attempt to satisfy the needs of all classes of electorates. The former consideration enables us to formulate two hypotheses pertaining to the issuances by the SNATs vs those by Local Governments. Hence, our first testable hypothesis – that the SNATs might be fully detached from any local constituency and, as such, have a higher ability to issue general-interest purposes GBs – runs as follows:

H1a. The green bonds issued by the SNATs, due to the lack of constraints from local constituencies, will more likely pursue general-interest purposes (i.e., 1. Renewable Energy; 2. Electricity and Gas).

This first hypothesis is based on the notion that supranational organizations, while working to promote the interests of transnational society (Stone Sweet and Sandholtz, 1997), devote funds to infrastructure investments so as to achieve general interest purposes such as regional competitiveness, employment, or international territorial cooperation (de Rus and Socorro, 2010).

We can further refine the previous reasoning. First, we expect that Local Governments' issuances might be less focused in terms of GB proceeds and, thus, have a lower HHI. Second, we anticipate that Local Governments' issuances will be less devoted to general-interest purposes (i.e., purposes 1. and 2.) and more to local-interest purposes (i.e., purposes from 3. to 7.). 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 identical 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.

The latter consideration leads us to formulate the following testable hypothesis.

H1b. The green bonds issued by Local Governments, due to the presence of constraints from local constituencies, will less likely pursue general-interest purposes (i.e., 1. Renewable Energy; 2. Electricity and Gas).

The third of our testable hypotheses, which is the second one pertaining to SNAT's GBs, 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 GBs they have issued due to 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' GBs. We thus hypothesize that:

H1c. The green bonds issued by the SNATs suffer a higher cost-of-funds vis-à-vis the comparable green bonds issued by Sovereigns or Local Governments.

Two further hypotheses regard the focused vis-à-vis dispersed allocation of proceeds collected through GB issuances. 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.

The first of these two hypotheses that are related to the benefit of concentration of the proceeds runs as follows. Our prior consideration on how Supranational or Sovereign entities may be more detached and less constrained from local constituencies compared to Local Governments leads to the next testable hypothesis.

H2a. The green bonds of Local Governments will more likely address general interest 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 GB issuances. In fact, GBs having a more focused allocation of their proceeds could also reduce the risk of not achieving their target. As such, we can formulate a fifth testable hypothesis.

H2b. The green bonds issued with a more intense focus of their proceeds will enjoy a lower cost-of-funds since investors like these green bonds more than less focused ones.

Finally, we can envisage a further effect relating to the size of the GB issuance. Ceteris paribus, a larger issue size might deliver a higher greenium (Wang et al., 2019) – i.e. a lower cost-of-funds. In these cases, in fact, investors could accept a lower return vis-à-vis smaller-sized GB issuances where larger-sized issuances grant two benefits stemming from more public information available on the issuance and also owing to the fact that larger issues more likely achieve the purpose set for the issuance. In particular, the former benefit might descend from the fact that larger-sized issuances attract monitoring by more analysts (Marquardt and Wiedman, 2005) as well as more coverage by the rating agencies (Fabozzi et al., 2014). This delivers another testable hypothesis.

H3. The larger issuances of green bonds enjoy a lower cost-of-funds vis-à-vis otherwise comparable green bonds, because investors suffer less asymmetry of information on these bonds.

3. Data, Methodology and Results

3.1 Data

To investigate the strategic motivations and performance of GBs issued by the three types of public sector entities (Supranational, Sovereigns, Local Governments), an empirical analysis is conducted.

Following Flammer (2020), the population of public sector GBs issued in the international capital markets between 2007 and 2020 was identified through Bloomberg's fixed-income database. More specifically, we have 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 financial data were then retrieved. The population comprises 969 GB issuances. However, due to the lack of data concerning yield-to-maturity and volatility, our econometric analysis is based on a subset of the above population, a sample of 199 public sector GB issuances, which represents about 20% of the population but the share is above one-third (35%) in terms of issued amounts and 44% of the number of GB issuers. Table 1 reports the comparative statistics of the population vs the sample of public sector GBs used for the purpose of our empirical analysis. Namely, the upper panel presents the distribution of the issuers for the entire population and for our sample of 199 public sector GBs, while the other two panels extend the comparison to the issuance size and the maturity of these GBs.

To validate the use of this sample of 199 public sector GBs 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 of maturity, 1-year default probability and yield-to-maturity for our sample of 199 GBs vs the population of 969 public GB issuances. For all these 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 AND TABLE 2 ABOUT HERE]

Besides collecting financial data on public sector GBs, we classify the destination of the 199 GBs' proceeds across several sectors. 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 first one

includes renewable energy, energy efficiency/emission reduction and low-emission transport and the second one 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 199 GBs' proceeds across seven different purposes: 1. Renewable Energy; 2. Electricity and Gas; 3. Energy Efficiency; 4. Transport; 5. Manufacturing; 6. Water and Waste Management; 7. Construction. Then, we discriminate issuances between general-interest (purposes 1. and 2.) vs local-interest (purposes from 3. to 7.). Data on the use of GBs' proceeds across such sectors were hand-collected on the basis of post-issuance reports periodically released by the issuers.[14]

This classification follows the idea that, vis-à-vis the others, the first two purposes bear more general consequences depending on various considerations. First, the purpose 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)[15]. Second, purposes 1. and 2. more actively contribute to abating CO2 emissions, thereby addressing the strongest form of negative externalities relating to global warming. While the inclusion of 1. Renewable Energy evidently does not need to be justified, also the inclusion of 2. Electricity and Gas appears amply validated in the literature. For instance, Mazzacurati et al. (2021) state that "Energy firms and utilities have a particularly high carbon footprint, making them relevant to our analysis …". In turn, estimating the sector-by-sector contributions, Ritchie et al. (2020) document that the bulk of contributions to global greenhouse gas emissions comes from Energy (73.2%), followed by Direct Industrial Processes (5.2%), Waste (3.2%), Agriculture, Forestry and Land Use (18.4%).[16] This conjecture is also supported by another simple observation. Namely, the strongest piece of evidence comes from REPowerEU (European Commission, 2022), the plan to face the double urgency to reduce Europe's energy dependence: the climate crisis, severely compounded by Russia's aggression against Ukraine, and EU's dependence on fossil fuels, which Russia uses as an economic and political weapon. It is notable that the two strongest actions consist in: i) accelerating the rollout of renewables (within purpose 1. Renewable Energy), where a dedicated EU Solar Strategy aims to double solar photovoltaic capacity by 2025 and install 600GW by 2030 and is coupled with parallel initiatives on Renewable Hydrogen and a

[14] In very few cases prospectuses were used when post-issuance reports were missing.
[15] 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.
[16] In turn, the largest component of the 73.2% is made by Energy use in industry (24.2%), followed by Energy use in buildings (17.5%), Transport (16.2%), Unallocated fuel combustion (7.8%), Fugitive emissions from energy production (5.8%), Energy use in agriculture and fishing (1.7%).

Biomethane Action Plan; ii) investing to create a resilient and interconnected EU energy infrastructure – e.g. the Trans-European Energy Networks; TEN-E – (within purpose 2. Electricity and Gas). Instead, proceeds going to the other five purposes – from 3. to 7. – seem to target a weaker form of negative externalities relating to local environmental conditions, possibly assuaging local voters. Hence, local-interest GBs may adhere to local electorates, whereas general-interest GBs likely abide by the global constituency.

Additionally, we calculate the focus of individual issuances through an Herfindahl-Hirschman index (HHI) measuring the extent of concentration of the proceeds across the seven purposes of the GB proceeds.

Further data were collected from Bloomberg on whether the investment projects financed through the destination of GB's' proceeds were originally selected by the public sector issuer applying the ESG metric.

To study whether strategic motivations and performance differ across the three categories of public sector issuers, we also constructed three dummy variables: *SNAT*, *Sovereign*, *Local Government*.

Going back to the issue of whether local issuers might be captured by their local constituencies, we figure out that such a capture could be more likely if the local environment features a higher degree of corruption. Hence, it is important to measure the level of public sector corruption. To assess the effect of the perceived level of public sector corruption across countries on the yields of GBs, we retrieved the related scores developed and assigned by Transparency International to 180 countries (with both advanced and poor economies) around the world: the *Corruption Perceptions Index* (CPI).[17]

To test the impact of key political events on the use of GBs' proceeds from public sector entities for pursuing general vs. local interest, we constructed a time trend (*Year*).

To test the effect of seasoning, we constructed a dummy variable (*Multi-Issuer*), which takes the value of 1 if the public sector entity has issued several GBs (above the sample median equal to 6) and 0 otherwise. The minimum number of issuances is 8 and the maximum number is 28.

Finally, to account for the heterogeneity of geographical locations of public sector GB issuers, currencies of issuance or regions of domicile (headquarters) can be used as control variables. We

[17] 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).

opted to control for regional locations (*Europe*, *North America*, *Latin America*, *Asia*, *Oceania*; *Africa* is the omitted benchmark dummy).

Definitions and sources of all variables with indication of expected signs are summarized in Table 3 Panel A and the related descriptive statistics are reported in Table 3 Panel B.

[INSERT TABLE 3 PANELS A AND B 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-interest purpose when issuing a GB.[18] In this sense, we follow the conventional practice of using a discrete and limited dependent variable model, where the probability of choosing a general-interest purpose for any public sector GB issuer is modelled as:

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

where:

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

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

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

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

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

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

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

where p is the probability that any public sector GB issuer i utilizes its GB proceeds to finance an infrastructure investment project of general-interest purpose.

The logit Model 1 considers the *SNAT* dummy variable, the *Sovereign* dummy variable, the *HHI* variable and the *Year* variable. The logit Model 2 replaces the *SNAT* dummy variable with the *Local Government* dummy variable (*Loc_Gov*), while it confirms the *Sovereign* dummy variable and the *HHI* variable. The logit Model 2 may thus be written as follows:

$$\log\left(\frac{p}{1-p}\right) = \alpha_0 + \alpha_1 Sovereign + \alpha_2 Loc\_Gov + \alpha_3 HHI + \alpha_4 Year + u_i \quad [5]$$

The logit Model 3 – compared to Model 2 – confirms the *Sovereign* dummy variable, the *Local Government* dummy variable (*Loc_Gov*), the *HHI* variable and the *Year* variable. Additionally, the logit Model 3 includes two interaction variables: *Sovereign* x *HHI* and *Local Government* x *HHI*. The logit Model 3 takes the following log-linear form:

$$\log\left(\frac{p}{1-p}\right) = \alpha_0 + \alpha_1 Sovereign + \alpha_2 Loc\_Gov + \alpha_3 HHI + \alpha_4 Sovereign\ x\ HHI + \alpha_5 Loc\_Gov\ x\ HHI + \alpha_6 Year + u_i \quad [6]$$

All three logit models are estimated by maximum likelihood.

Second, we want to explore the issue of the costs of GB issuances. To that end, we employ a multivariate regression model 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 may be formally expressed as follows:

$$\begin{aligned} YTM\_mid_i = {} & \beta_0 + \beta_1 Vol_{260} + \beta_2 SP\_Rating + \beta_3 Ln\_Issue + \beta_4 Maturity + \beta_5 ESG\_Select \\ & + \beta_6 Renew\_En + \beta_7 En\_Eff + \beta_8 Transport + \beta_9 WaterWaste\_Mgmt \\ & + \beta_{10} HHI + \beta_{11} SNAT + \beta_{12} Loc\_Gov + \beta_{13} Europe + \beta_{14} North\_America \\ & + \beta_{15} Latin\_America + \beta_{16} Asia + \beta_{17} Oceania + \varepsilon_i \end{aligned} \quad [7]$$

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-interest purpose when issuing a GB and (*post* issuance) deciding which infrastructure projects the related financial proceeds should be allotted to. Allocation of GB 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 1, Model 2 and Model 3) are presented in Table 4.

[INSERT TABLE 4 ABOUT HERE]

The dummy variable associated with SNATs (*SNAT*) as GB issuers has a positive and highly significant (at 1% level) coefficient in Model 1. This result supports the idea that the destination of proceeds from Supranational GB issuances more likely targets investment projects of general-interest purpose. 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' GB 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 *H1a*.

The coefficient of the *Sovereign* dummy variable, albeit it has a negative sign in both Models 1 and 2 (with statistical significance at 5% level in Model 2), becomes positive (with no statistical significance) in Model 3, which strengthens the notion that both Supranational and (partially) Sovereign GB issuances are more likely addressed to financially support infrastructural investment projects of general-interest purpose in line with *H1a* and *H2a*. However, this mixed finding associated with the switch of sign between Models 1 and 2 and Model 3 suggests that Sovereign institutions (central governments/treasuries), when issuing their GBs and deciding which sectors the related

proceeds should be allocated to, are positioned between SNATs and Local Governments: they may sometimes target projects of general-interest purpose, while in other circumstances they may try to achieve targets of local impact.

The empirical evidence of Models 2 and 3, where the SNAT dummy variable is replaced by the *Local Government*'s one accounting for when Local Governments (*Loc_Gov*) are GB issuers corroborates the previous finding. Their coefficients are negative and have a strong statistical significance (at 1% level), thus conveying that GBs issued by Local Governments are more likely to finance infrastructure investments of local-interest purpose. Hence, *H1b* is fully supported.

The coefficient of the *HHI* variable accounting for the *focus* of individual GB issuances, calculated through an Herfindahl-Hirschman index (HHI) measuring the extent of concentration of the GB proceeds across the seven sectors considered based on our proposed classification, has a positive sign and a strong statistical significance (at 1% level) across Models 1 and 2. However, when we introduce the interaction term *Loc_Gov* x *HHI* (Model 3), we see that this new variable is significant and positive while the *HHI* variable per se loses its significance. This finding suggests that having *focused* GB issuances is particularly important for addressing Local Government's issuances towards the general interest. Indeed, although the coefficient of *Loc_Gov* x *HHI* is statistically significant only at the 10% level, the value of this coefficient is positive and equal to 2.879, this goes to counter the effect of *Loc_Gov* whose coefficient is significant, negative and equal to -3.419. So, in the hypothetical case in which local government A has *HHI* = 0 while local government B has *HHI* = 1, the overall effect of reducing the likelihood of pursuing general interest for A is -3.419 while for B the effect is -3.419 + 2.879 = -0.540 with a drop of 84.2% 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 issuance that identifies a local government which enjoys a milder constraint from its local constituencies. This provides some support for *H2a*.

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 sectors attract 90.5% of the issuances. In particular, Construction counts 64 (32.2%) of the 199 issuances, while both Renewable Energy and Transport count 58 (29.2%). Another noteworthy feature is that *Loc_Gov* allocate 46 of their 90 issuances (51.1%) to Construction, while SNATs allocate 49 of their 96 issuances (51.0%) to Renewable Energy and *Sovereign*'s bulk of issuances goes to Transport (10 or 76.9%). The middle panel reveals that the average size of issuance is lowest for *Loc_Gov* (402.2 million), slightly larger for SNATs (449.1) and largest for *Sovereign* (1,404.2). Finally, the bottom panel shows that HHI reaches on average the highest value for *Loc_Gov* (0.623), noticeably higher than for *Sovereign* (0.479) and SNATs (0.459).

[INSERT TABLE 5 ABOUT HERE]

The *Year* variable accounts for the presence of a trend across the sample period (2012-2019) 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 GBs by public sector entities. As its coefficient is negative but not statistically significant across all models (Model 1, Model 2 and Model 3), we can conclude that these pivotal events for policy-making about sustainable transition have not affected the pursuit of general vs. local interest use of proceeds.

The OLS regression, which obtains an adjusted R-squared of 81.48%, sheds new light on the determinants of public sector GBs' cost-of-funding. The results of our OLS regression model are presented in Table 6.

[INSERT TABLE 6 ABOUT HERE]

The positive and strongly significant coefficient of the *volatility* variable confirms that the greater the volatility of GB prices in the secondary market, the higher the return required by investors holding GBs.

In line with conventional expectations, returns of GBs and their assigned credit ratings are inversely related, implying that as the rating of a GB improves its yield-to-maturity declines. The magnitude of the coefficient of the *SP_Rating* variable (- 1.48) underlines a relatively high, adverse impact of the credit rating on GB returns.

Interestingly, the coefficient of the variable associated with the issued amount (*Ln_Issue*) is negative and strongly significant (at 1% level). This finding supports the notion that the (increasing) size of the underlying infrastructure project(s) financed by the GB issuance matters and is rewarded by investors by accepting a lower return. Indeed, larger-sized issuances provide two benefits to investors: (i) they reduce information asymmetry by attracting greater analysts' monitoring and rating agencies' coverage; (ii) they are more impactful being more likely to achieve the targets set in the issuance contract. Hence, the higher the amount of public information available on the GB issuance, the lower the yield-to-maturity / cost-of-funding required by investors (and the higher the *greenium* enjoyed by the issuer). The greater the impact of the underlying infrastructure (proportional to its size) and its likelihood to accomplish the purposes set for the related GB issuance, the higher the discount on the yield-to-maturity / cost-of-funding of related GBs borne by investors (and the higher the *greenium* enjoyed by the issuer). *H3* is thus strongly supported.

The coefficient of the *maturity* variable has a negative sign and is highly significant (at 1% level), thus providing empirical support for the presence of an inverted yield curve due to the effect of the extension of the quantitative easing program that central banks have been carrying out following the Global Financial Crisis of 2008-2009. This implies that the longer the maturity of the GB, the lower the return required by investors.

The *ESG_Select* dummy variable accounting for the ESG-driven selection of the infrastructure project(s) to be financed using the proceeds of the GB issuance is not statistically significant, thus suggesting no relevance to GB returns.

The coefficient of the variable capturing the *focus* of individual GB issuances, calculated through *HHI* measuring the extent of concentration of the GB proceeds across the seven different sectors considered, is negative and strongly significant (at 1% level). This finding suggests that more *focused* GB issuances require a lower cost-of-funding, enabling issuers to enjoy a higher *greenium*. Hence, investors reward issuers of GBs, whose proceeds are predominantly or exclusively destined to finance single-sector infrastructures, by accepting to earn a lower return and thus reducing their bond placing costs. The magnitude of the coefficient (- 1.73) underscores a relatively high, negative effect of more *focused* GB issuances on their returns for investors. This finding provides strong support to *H2b*.

Interestingly, the coefficients of the dummy variables associated with SNATs (*SNAT*) and Local Governments (*Loc_Gov*) as GB issuers are both positive and highly significant from a statistical standpoint (at 1% level), thus suggesting that *Sovereign* GB issuers exercise a greater placing power with the result of pushing yields-to-maturity, and hence their cost-of-funding, downward in their favor. The reverse occurs for GBs issued by SNATs and Local Governments, 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 GBs are destined to. This translates into a higher cost-of-funding. *H1c* is thus strongly supported by our empirical analysis. The reason why also Local Governments suffer a higher cost of funding (a lower *greenium*) may be related to the fact that these issuers generally have lower placing power with investors compared to national governments. Local Governments, in fact, compared to national governments, are more occasional issuers, may be penalized by a perception of higher risk and may release less and less structured information.

Additional Results

Among sectorial dummy variables, the *Renewable Energy* and *Water and Waste Management* regressors have positive and statistically significant coefficients (at 1% and 5% level respectively). This provides evidence that Renewable Energy and Water and Waste Management infrastructures are riskier as GBs, whose proceeds are destined for such purposes, imply a higher return. The rest of sector variables (*Energy Efficiency*, *Transport*) show no statistically significant correlation with GBs' returns.

Finally, our OLS regression model controls for regions of domicile of public sector GB issuers. Among the regional dummy variables, the *Europe* and *Latina America* regressors are both statistically significant (at 10% and 5% level respectively). However, the coefficient of the *Europe* variable is positive while that of *Latin America* is negative. Our findings provide empirical evidence that, on one hand, the few projects to be financed through the issuance of GBs in Latin America might determine a positive selection bias leading to a more severe screening of the best sustainable infrastructures ("cherry-picking" strategy). The lower degree of riskiness of such selected projects is then rewarded by investors by accepting a lower return on related GBs. On the other hand, the greater number of eligible infrastructure assets available throughout Europe for green financing fosters a negative project selection bias when choosing the purposes of destination for GB proceeds ("market for lemons" strategy). The greater level of riskiness of such projects likely requires higher yields-to-maturity from GB investors. The comparison between Latin America and Europe is rather intriguing as the two regions are similar showing heterogeneity of public sector GB issuers. However, as already noted in section 3, Latin America accommodates the highest proportion of Sovereign GB issuers compared to the rest of the world, while Local Governments prevail in Europe. It can thus be argued that in Latin America Sovereign GB issuers seem to be better at selecting financially viable projects with a lower degree of bias compared to what occurs in Europe where the heaviest issuance of GBs from less structured and organized entities, such as Local Governments, may lead to a more pronounced adverse selection bias due to a less rigorous screening of eligible projects.

4. Robustness Checks

To confirm the robustness of our main results, we have extended our previous logit and OLS regression models.

The robustness of our logit regression analysis is validated by integrating Model 1 of Table 4 with a variable associated with the issued amount (*Ln_Issue*), controlling for the size of the GB issuance and the underlying infrastructure project financed through the related proceeds, and the five regional dummy variables (*Europe*, *North America*, *Latin America*, *Asia*, *Oceania*) controlling for the regions

of domicile of public sector GB issuers included in our sample. The results of the logit regression robustness are shown in Table 7.

Our extended logit regression shows that the coefficient of the *SNAT* dummy variable is positive and strongly significant (at 1% level), thus confirming that SNATs are more likely to utilize their GB proceeds to finance investment projects of general-interest purpose (*H1a*). The finding concerning the *Sovereign* dummy variable with a positive but not statistically significant coefficient corroborates the idea that national treasuries are in general more inclined to target projects having a collective impact, sometimes being also tempted to adhere to local constituencies through the funding of local investments thus mimicking the behavior of Local Governments. This also provides further support to *H1b*.

Analogously to what applies to the main logit regression, the *HHI* variable is positive and strongly significant (at 1% level), which reinforces – in line with *H2a* – the notion that public sector institutions aimed at issuing GBs to accomplish general-interest targets are more likely to concentrate the use of proceeds into fewer sectors 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 GB issuance (and of the related investment projects funded via the collection of proceeds from investors) exerts no significant effect on the above results.

Finally, in our extended logistic regression model we control for regions of domicile of public sector GB issuers. Among the regional dummy variables, the *Asia* regressor is negative and statistically significant (at 1%), thus implying that public sector GB issuers in Asia are more likely to disburse proceeds from GB issuances to finance investment projects having an impact at local level. The rest of regional dummy variables (*Europe*, *North America*, *Latin America*, *Oceania*) show no statistically significant correlation with the probability of allocating GB proceeds to a general-interest purpose.

[INSERT TABLE 7 ABOUT HERE]

The robustness of our multivariate regression analysis is validated by integrating a reduced, more parsimonious OLS model (using fewer key variables) with the inclusion of the score assigned to 180 countries around the globe by Transparency International to assess their perceived levels of public sector corruption (*Corruption Perceptions Index – CPI*). Our reduced OLS model omits target sectors for the allocation of GB issuances' proceeds and regions of domicile of public sector GB issuers. We employ two specifications: Model 1, which includes the *CPI* score along with the key variables from the main OLS model of Table 6; Model 2, which, besides including the above variables, adds the year fixed effects (Table 8).

The empirical evidence resulting from the main OLS regression is still confirmed through the robustness checks. *Volatility* is positively correlated with the returns of public sector GBs. An improvement (upgrade) in the credit rating (*SP_Rating*) determines a decrease in the yield of a public sector GB, thus implying a negative correlation between the creditworthiness of the public sector entity and the returns on GBs accepted by investors. Greater sizes of GB issuances (*Ln_Issue*) and of underlying investment projects enable public sector issuers to enjoy a lower cost-of-funding as investors are more prone to accept lower returns. This finding strengthens the empirical validation of *H3*. The *maturity* of public sector GBs is negatively correlated with their returns. Interestingly, compared to the main OLS model, the coefficient of the *ESG_Select* dummy variable not only has a negative sign but is also statistically significant (at 10% level), thus conveying that the use of the *ESG* metric to select projects to be financed through the proceeds of GB issuances enables public sector issuers to enjoy a lower cost-of-funding. The choice of *focusing* proceeds of GB issuances on the financing of investment projects across fewer sectors (*HHI*) is rewarded by investors by accepting lower returns, which translates into a lower cost-of-funding for public sector issuers. This result provides further support for *H2b*.

H1c is further corroborated by the positive and strongly significant coefficients of the *SNAT* and *Local Government* (*Loc_Gov*) dummy variables. SNATs and Local Governments are forced to issue GBs at higher costs for different reasons. Allegedly, SNATs are less capable of monitoring the efficacy of their target project funding compared to Sovereign issuers. Local Governments tend to place their GBs less frequently in the global markets and with less structured information compared to Sovereign issuers, which exacerbates the risk attitude of investors. Hence, the cost-of-funding of such types of public sector GBs is higher relative to that of Sovereign bonds.

The *Corruption Perceptions Index* (CPI) variable 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 the CPI with the S&P rating turns out significant implying that the effect of diverse corruption levels will have a different impact depending on the level of the rating of the country.

[INSERT TABLE 8 ABOUT HERE]

We have also conducted an additional robustness analysis which detects the presence of an interesting seasoning effect. We first estimate a further logistic regression with the following log-linear form:

$$\log\left(\frac{p}{1-p}\right) = \alpha_0 + \alpha_1 SNAT + \alpha_2 HHI + \alpha_4 Year + u_i$$

[8]

where p is the probability that any public sector entity i is a multi-issuer, having issued several GBs with a number above the sample median (equal to 6). Second, we re-estimate the reduced OLS model on a restricted sample of public sector GBs only limited to 2019 (including 70 bonds). The choice of restricting the sample only to 2019 is due to the fact that this is the last year in our dataset which may help us capture important evolutions in investors' attitude towards the GBs market. Indeed, in some respects, 2018 seems to be a turning year for investors' interest in sustainable finance considering that the largest investment firm in the world issued a statement in this sense. Namely, the CEO of BlackRock, Fink (2018) 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?". This was a major turnaround from the previous attitude identifying the maximization of shareholder value as the sole purpose of the company.[19] Thus, this

[19] An additional sign that the times were changing in ways that may favor also sustainable finance can be found in the stance of the Business Roundtable, the association representing the CEOs of America's leading companies. In 2019 Business Roundtable revised its Statement on the Purpose of a Corporation to focus it on the following items: "i) Delivering value to our customers [...] meeting or exceeding customer expectations; ii) Investing in our employees [...]compensating them fairly and providing important benefits [...] supporting them through training and education that help develop new skills for a rapidly changing world [...] foster[ing] diversity and inclusion, dignity and respect; iii) Dealing fairly and ethically with our suppliers; iv) Supporting the communities in which we work [...] respect[ing] the people in our communities and protect[ing] the environment by embracing sustainable practices across our businesses; v) Generating long-term value for shareholders, who provide the capital that allows companies to invest, grow and innovate. We are committed to transparency and effective engagement with shareholders." This revision of what the Business Roundtable believes should be the purpose of a corporation represents a U-turn with respect to the position it had in the past, when by and large it supported the view that a corporation should just focus on maximizing shareholder value – i.e., short-term profits. This 180-degrees turn was noticed by the New York Times in an article titled "Shareholder Value Is No Longer Everything, Top C.E.O.s Say." Harrison, Phillips & Freeman (2019) explain that "in the 1970s, so-called free market economists at the University of Chicago led an effort to tip the balance toward shareholder primacy. Perhaps the most famous of the quotes on this subject was by Nobel laureate Milton Friedman (1970), who declared in an essay in the New York Times Magazine that shareholders own the corporation and that 'the social responsibility of business is to increase its profits'." Indeed, Freeman (1994) presented a wholly alternative view whereby the legitimation of a company comes from it serving its multiple stakeholders, as opposed to catering just for its shareholders. The countering positions of the two scholars have become labelled as the "Friedman vs. Freeman Debate" and, clearly, until 2019 the Business Roundtable was siding with Friedman while it now seems to have opened up to Freeman. This is not just a scholarly debate but it will impact the very nature of corporations, what they stand for, with ample ramifications also favoring sustainable finance.

change in investors' attitude in favor of sustainable finance might exert important effects on the attractiveness of GBs, and these effects might be visible exactly in 2019.

Table 9 summarizes the results of this further robustness analysis. In particular, the new logit model 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 issuances (higher *HHI*). This result implies that SNATs have issued more GBs than other public sector institutions over the observed period. In turn, while confirming most of the results, the new reduced OLS model shows two distinct novelties. Specifically, on their issuances of 2019, both the *SNATs* and the *Loc_Gov* 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 could also descend from a kind of seasoning effect. In fact, as we can appreciate from Figure 2, certainly for the *SNATs* – but to some extent also for the *Loc_Gov* – the distribution over the years of the issuances is front-loaded, whereas it is back-loaded for the *Sovereigns*. 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 issuances was front-loaded.

[INSERT TABLE 9 ABOUT HERE]

5. Conclusions

As the world community struggles to tackle global warming and other threats endangering the planet, the good news is that a new breed of finance – Sustainable Finance – is coming to the rescue. One of the most dynamic components of Sustainable Finance is Green Bonds (GBs). The first GB issue – called Climate Awareness Bond – was launched back in 2007 by the European Investment Bank. The key characteristic of GBs is that the proceeds from their issuance are assigned to finance projects that are valuable to build infrastructures facilitating environmentally responsible behavior. While initially GB issuances were relatively marginal and reserved to Supranational Entities (SNATs), since 2013, the takeoff of corporate GBs has been exponential. This new phenomenon is attracting great interest by scholars, resulting in a now buoyant strand of literature on corporate GB issues. However, GBs issued by public sector entities are still important, and may exercise a stewardship in promoting the sustainable transition (Heine et al., 2019).

This paper aimed to remedy the under-researched status of public sector GBs, which over time were issued not only by SNATs, but also by Local Governments (LGs), and, more recently, by Sovereigns (SOVs) too. We first described the overall trends of this GB market segment, which still represents close to one third of total GB issuances. However, the major thrust of our work consisted

in investigating whether strategic motivations and performance differ across the three categories on a sample of GBs. To that end, we collected key financial data and (painstakingly) classified the destination of GBs' proceeds across seven different purposes: 1. Renewable Energy; 2. Electricity and Gas; 3. Energy Efficiency; 4. Transport; 5. Manufacturing; 6. Water and Waste Management; 7. Construction. Next, we distinguished issuances between general- (1. and 2.) vs local-interest (from 3. to 7.) purposes, and calculated their focus through an Herfindahl-Hirschman concentration index. The inner logic behind this distinction stems from considering that, while all of the purposes give a contribution, the first two purposes may have a more general impact on the sustainable transition, whereas the other purposes may give a local payoff. Indeed, the first two purposes seem the most effective in terms of abating CO2 emissions, thereby addressing the strongest form of negative externalities relating to global warming, as opposed to weaker forms of negative externalities like local pollution. Accordingly, conjecturing that general-interest GBs – responding to the global constituency – have greater value than local-interest GBs – responding to local electorates – we ventured to study the determinants of choosing general vs local-interest in GB issuances. Alongside, we investigated another dimension relating to the cost of issuing GBs, whereby we estimated the determinants of GBs' yield-to-maturity. Finally, our estimates of Logit and OLS regressions reached three salient findings. First, more *focused* issuances more likely target general-interest purposes and require a lower cost-of-funding. Second, Supranational issuances more likely target general-interest purposes, but imply higher cost-of-funding. Third, a more concentrated destination of proceeds, leading to more *focused* issuances, enables Local Governments to switch their strategic financing target towards general interest projects.

Our results have policy implications for the fine tuning of GB issuance strategies. Specifically, if they believe that pursuing general-interest purposes is worthier than pursuing local-interest purposes, then policy makers should increase the focus of their GB issuances and consider entrusting the issuance of GBs to public entities – like SNATs and SOVs as opposed to LGs – more detached from local electorates. In addition, more focused GB issuances would deliver lower financing costs. Sovereign issuances would also mitigate bond placing costs.

Two caveats are in the order. First, our results were achieved on a sample and, thus, might not generalize to the universe of public sector GBs. Second, the vibrant growth of the market might imply that GBs are undergoing changes in their nature, as also suggested by the introduction of new sustainable securities such as Sustainability (Linked) Bonds and, more recently, Pandemic Bonds. If, indeed, the nature of GBs is changing, then old issuances would give little guidance on how the new issuances work.

Our contribution may open the way to research avenues yet to be addressed. We will venture on a non-exhaustive short list of suggestions. An interesting research question pertains to the hypothesized stewardship exerted by public sector GBs. From this perspective, one might wish to investigate whether, at national level, public sector GBs lead the expansion of corporate GBs. Another dimension worth exploring is whether substitutability or complementarity ensues across GB issuances by SNATs, SOVs and LGs. Although, prima facie, the past trends appear to suggest complementarity rather than substitutability – as evidenced by the fact that the rise of SOVs' GB issuances did not apparently damage GB issuances by SNATs or LGs – the matter is all but settled. Finally, it would be interesting to explore whether GB issuances lead to imitation by neighbors. That could be studied at three different levels. At the domestic level, is there imitation across LGs? Next, at the regional level, is there imitation across SOVs? Lastly, at the global level, is there imitation across SNATs? Possible evidence of imitation would indicate that GB issuances not only remove negative environmental externalities but may create positive externalities via imitation by other public sector issuers.

References

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, 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.

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.

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

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.

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.

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

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

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).

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. (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.

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.

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?. *Journal of Business*. 74, pp. 613– 635.

Harrison, J. S., Phillips, R. A., & Freeman, R. E. (2019). On the 2019 Business Roundtable "Statement on the Purpose of a Corporation". *Journal of Management*, 0149206319892669.

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).

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

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.

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.

Larcker, D. F., & Watts, E. M. (2019). Where's the greenium?. *Rock Center for Corporate Governance* at Stanford University Working Paper, (239), 19-14.

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.

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).

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.

European Commission (2022). REPowerEU: A plan to rapidly reduce dependence on Russian fossil fuels and fast forward the green transition.
https://ec.europa.eu/commission/presscorner/detail/en/IP_22_3131

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.

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.

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.

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.

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.

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.

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

	Population (969 Issuances)	**Sample (199 Issuances)**
Time Period of Issuances	2007-2020	2012-2019
Public Sector Green Bond Issuers (#):	109	48
SNATs	13	10
Local Governments	80	33
Sovereigns	16	5
Issuance Size (aggregate amount in billions of euro):	€ 282.68	€ 98.37
SNATs	€ 83.4	€ 44.11
Local Governments	€ 114.17	€ 36.00
Sovereigns	€ 85.11	€ 18.26
Maturity (in years; mean)	8,8	9,03

Source: Bloomberg

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

	One Sample *t*-Test		
Variables >>>	Maturity	1-Year Default Probability	Yield-to-Maturity
N	199	194 (*)	199
Mean (Sample)	9.03	0.0198	0.8996
Mean (Population)	8.7977	0.0078	1.20
Mean Difference	0.232	0.012	-0.300
t	0.528	1.338	-1.193
P-value (two-tailed)	0.598	0.183	0.234
H_0	Not Rejected	Not Rejected	Not Rejected

(*) For 5 issuances information about the related 1-year default probability is not available.

Table 3. 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 GB, percentage, 2012-2019			Bloomberg
General Interest – GIP	General Interest Purpose, dummy equal to 1 if top destination of proceeds in 1. Renewable Energy or 2. Electricity & Gas, 2012-2019			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, percentage, 2012-2019	+		Bloomberg
Rating – S&P_Rating	Rating issued by S&P on each GB, scale 1-8, 2012-2019	-		Bloomberg
Issue Size – Ln_issue	Issued amount of each GB, natural logarithm of billions of euro, 2012-2019	-	+	Bloomberg
Maturity – Maturity	Maturity of each GB, in years, 2012-2019	-		Bloomberg
Focus – HHI	Herfindahl-Hirschman index across the 7 purposes of destination of the GB proceeds, 2012-2019	-	+	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 – Loc_Gov	Dummy equal to 1 if the GB was issued by a Local Government such as municipal, province or regional entities, 0 otherwise	+	-	Authors' calculations on Bloomberg
Sovereign Issuance – Sovereign	Dummy equal to 1 if the GB was issued by a Sovereign such as a national Treasury, 0 otherwise	-	+	Authors' calculations on Bloomberg
ESG Selection Project – ESG_Select	Dummy equal to 1 if the selected project to be financed with the GB issuance has been chosen applying ESG metric, 0 otherwise	-		Authors' calculations on Bloomberg
Perceived Level of Corruption in the Public Sector – Corruption Perceptions Index	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); 2012-2019	-		Transparency International
Yearly Trend – Year	Years associated with each GB issuance accounting for the time trend across the sample, 2012-2019		?	Bloomberg
Europe	Dummy equal to 1 if the GB issuer is a SNAT, a Local Government or a Sovereign 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 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 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 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 in Oceania, 0 otherwise	?	?	Authors' calculations on Bloomberg
Renewable Energy – Ren_En	Dummy equal to 1 if the higher percentage of the proceeds of the single issuance were 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 higher percentage of the proceeds of the single issuance were 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 higher percentage of the proceeds of the single issuance were 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 higher percentage of the proceeds of the single issuance were used to finance projects in the water and waste management sector and 0 otherwise.	?		Authors' calculations on post-issuance reports

Table 3. Descriptive Statistics – continued

Panel B – Dependent and independent variables statistics

Variable name	Description – formula	No. obs.	Min.	Mean	Max.	St. Dev.
Return	Yield at maturity calculated on the basis of average prices between bid and ask quotations.	199	-0.72	0.90	32.86	3.55
Volatility	The standard deviation of the prices referring to the market trades of the last 260 business days: $\sigma = \sqrt[2]{\frac{\sum(x_i - \mu)^2}{n-1}}$	199	0.19	3.89	32.26	4.51
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	199	1	7.39	8	1.06
Issue Size	Natural logarithm of the issued amount of Green Bonds	199	13.68	19.34	22.53	1.45
Maturity	Maturity of the issuance computed (in years) as difference between the day of its issuance and the day of its maturity.	199	3	9.03	31	6.21
Focus	The HHI measures the industry concentration of the GB issuances given the use of their proceeds and their percentages along seven strategic sectors. $\sum {s_i}^2$ where s_i is the percentage of the issuance used for project in the i-th sector (with *i* which varies between 1 and 7).	199	0	0.54	1	0.24
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).	199	29.76	64.31	89	17.79

Table 4. Logit Regression Results

Dependent Variable: General Interest (GIP)						
N° of Observations: 199	**Model 1**		**Model 2**		**Model 3**	
	Coefficient	p-Value	Coefficient	p-Value	Coefficient	p-Value
SNAT	1.692*** (0.389)	0.000				
Sovereign	-0.106 (0.843)	0.900	-1.798** (0.827)	0.030	1.410 (2.052)	0.492
Loc_Gov			-1.692*** (0.389)	0.000	-3.419*** (1.086)	0.002
HHI	2.517*** (0.772)	0.001	2.517*** (0772)	0.001	1.064 (1.358)	0.434
Sovereign x HHI					-7.761 (5.416)	0.152
Loc_Gov x HHI					2.879* (1.730)	0.096
Year	-0.133 (0.106)	0.212	-0.133 (0.106)	0.212	-0.142 (0.108)	0.187
Constant	264.606 (214.140)	0.217	266.298 (214.132)	0.214	286.122 (217.164)	0.188
Cox & Snell R2	0.144		0.144		0.179	
Nagelkerke R2	0.196		0.196		0.244	
Loglikelihood	231.739		231.739		223.461	

Table 5. Degree of Proceeds' Concentration Across Infrastructure Sectors

	Number of Issuances		
Issuer Type >>>	SNAT	Sovereign	Local Government
Infrastructure Sector:			
Renewable Energy	49		9
Electricity & Gas	1	2	
Energy Efficiency	1		1
Transport	27	10	21
Manufacturing	1		
Water & Waste Management			13
Construction	17	1	46
TOTAL	*96*	*13*	*90*
	Average Issuance Amount (€ mln)		
Issuer Type >>>	SNAT	Sovereign	Local Government
Infrastructure Sector:			
Renewable Energy	445.6		643.8
Electricity & Gas	308.8	823.5	
Energy Efficiency	292.7		300.0
Transport	515.6	1.585.8	499.5
Manufacturing	604.6		
Water & Waste Management			537.7
Construction	362.0	750.0	274.5
MEAN VALUE	*449.1*	*1404.2*	*402.2*
	Average HHI [0 ≤ HHI ≤ 1]		
Issuer Type >>>	SNAT	Sovereign	Local Government
Infrastructure Sector:			
Renewable Energy	0.476		0.711
Electricity & Gas	0.526	0.258	
Energy Efficiency	0.522		0.457
Transport	0.462	0.535	0.629
Manufacturing	0.627		
Water & Waste Management			0.916
Construction	0.387	0.362	0.524
MEAN VALUE	*0.459*	*0.479*	*0.623*

Table 6. OLS Regression Results

Dependent Variable: Yield-To-Maturity (YTM_mid)		
N° of Observations: 199		
	Coefficient	t-Student
Vol_260	0.696*** (0.402)	17.32
SP_Rating	-1.487*** (0.194)	-7.67
Ln_Issue	-0.522*** (0.089)	-5.89
Maturity	-0.295*** (0.025)	-11.93
ESG_Select	-0.553 (0.464)	-1.19
Renew_En	0.971*** (0.357)	2.72
En_Eff	-0.381 (1.131)	-0.34
Transport	0.327 (0.342)	0.96
WaterWaste_Mgmt	1.183** (0.514)	2.30
HHI	-1.729*** (0.554)	-3.12
SNAT	2.097*** (0.614)	3.42
Loc_Gov	1.671*** (0.531)	3.14
Europe	1.098* (0.562)	1.95
North America	0.555 (0.596)	0.93
Latin America	-1.858** (0.922)	-2.02
Asia	0.389 (0.628)	0.62
Oceania	-0.781 (0.871)	-0.90
Constant	20.470*** (2.181)	9.39
Adj R2	0.8148	
Model F	52.25***	

Table 7. Robustness of Logit Regression Results

Dependent Variable: General Interest (GIP)		
N° of Observations: 199		
	Coefficient	p-Value
SNAT	1.805*** (0.450)	0.000
Sovereign	0.146 (0.970)	0.880
HHI	2.640*** (0.861)	0.002
Ln_Issue	0.051 (0.121)	0.670
Europe	-1.049 (0.780)	0.179
North_America	-0.245 (0.793)	0.758
Latin_America	-0.666 (1.048)	0.525
Asia	-3.173*** (1.039)	0.002
Oceania	-0.225 (1.209)	0.852
Constant	- 3.001 (2.474)	0.225
Cox & Snell R2	0.229	
Nagelkerke R2	0.312	
Loglikelihood	210.931	

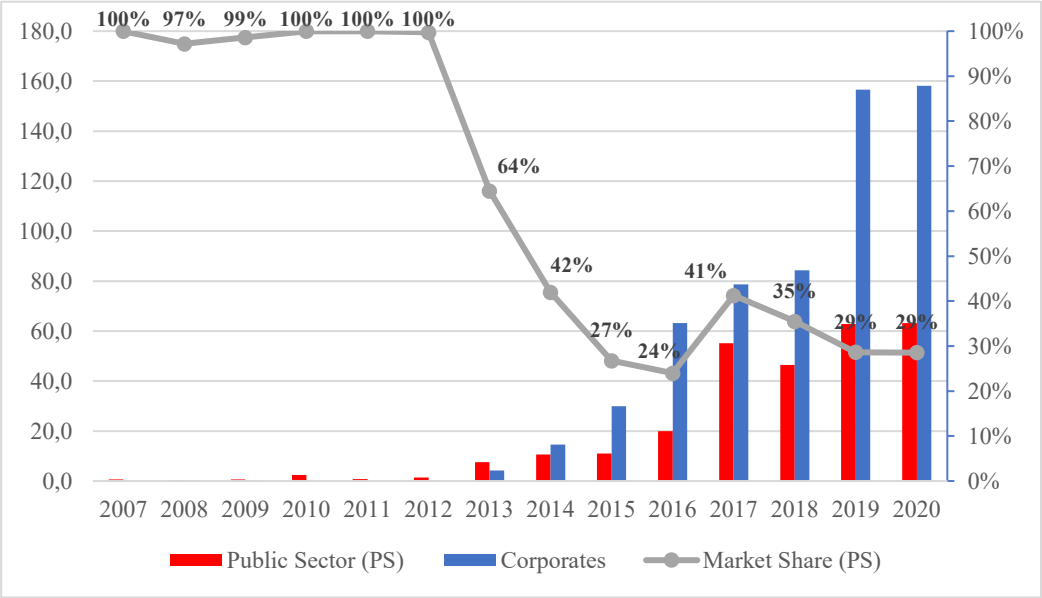
Table 8. Robustness of OLS Regression Results

Dependent Variable: Yield-To-Maturity (YTM_mid)				
N° of Observations: 199	**Model 1**		**Model 2**	
	Coefficient	t-Student	Coefficient	t-Student
Vol_260	0.622*** (0.417)	14.93	0.657*** (0.043)	15.44
SP_Rating	-2.449*** (0.441)	-5.56	-1.986*** (0.455)	-4.37
Ln_Issue	-0.516*** (0.086)	-6.03	-0.579*** (0.087)	-6.63
Maturity	-0.256*** (0.027)	-9.67	-0.272*** (0.027)	-9.98
ESG_Select	-0.763* (0.458)	-1.67	-0.534 (0.494)	-1.08
HHI	-1.147** (0.519)	-2.21	-1.071** (0.514)	-2.08
SNAT	1.950*** (0.602)	3.24	1.315** (0.613)	2.15
Loc_Gov	1.238** (0.540)	2.29	0.796 (0.543)	1.47
Corruption Perceptions Index	-0.185*** (0.059)	-3.15	-0.139** (0.060)	-2.32
Corruption Perceptions Index x SP_Rating	0.026*** (0.008)	3.35	0.019** (0.008)	2.41
Constant	28.302 (3.801)	7.45	27.335 (3.804)	7.19
Year Fixed Effects	No		Yes	
Adj R2	0.8013		0.8101	
Model F	80.84***		50.67***	

Table 9. Robustness Analysis of Seasoning Effect

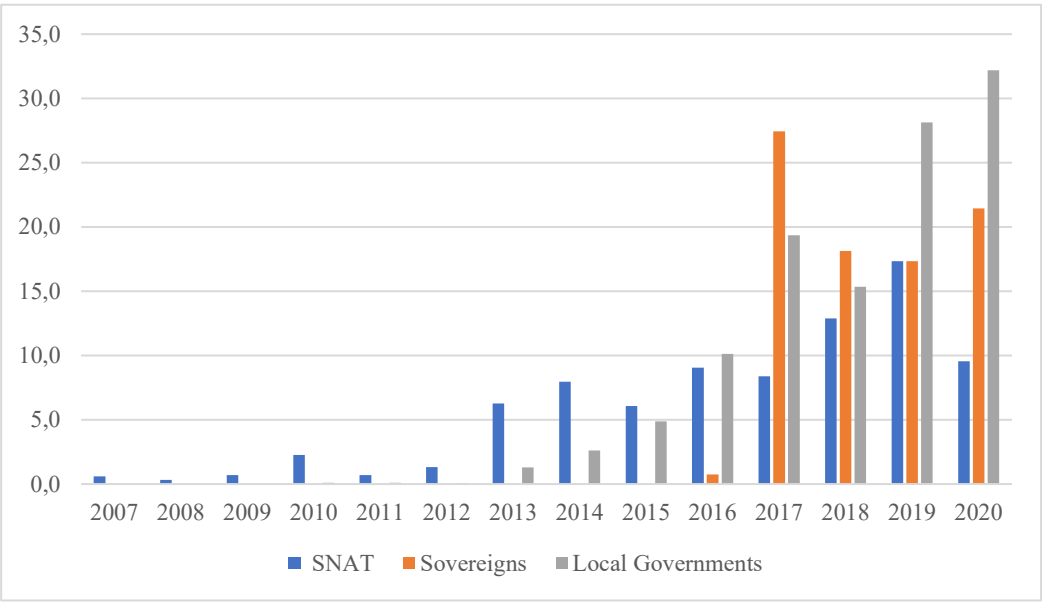
Dependent Variable: Multi-Issuer (MI)			*Dependent Variable*: Yield-To-Maturity (YTM_mid)		
N° of Observations: 199	**Logit Model**		N° of Observations: 70	**OLS Model**	
	Coefficient	p-Value		Coefficient	t-Student
SNAT	5.795*** (0.870)	0.000			
HHI	5.603*** (1.491)	0.000			
Year	-0.204 (0.174)	0.240			
Constant	404.686 (350.101)	0.248			
			Vol_260	0.177*** (0.039)	4.55
			SP_Rating	0.253 (0.543)	0.47
			Ln_Issue	-0.423*** (0.070)	-6.04
			Maturity	-0.075*** (0.023)	-3.22
			ESG_Select	0.938* (0.500)	1.87
			HHI	-0.842* (0.466)	-1.81
			SNAT	-0.993* (0.529)	-1.88
			Loc_Gov	-0.891** (0.430)	-2.07
			Corruption Perceptions Index	0.025 (0.062)	0.41
			Corruption Perceptions Index x SP_Rating	-0.004 (0.008)	-0.52
			Constant	7.533* (4.347)	1.73
Cox & Snell R2	0.527		Year Fixed Effects	No	
Nagelkerke R2	0.703		Adj R2	0.447	
Loglikelihood	126.460		Model F	6.576***	

Figure 1. Distribution of green bond issuances among corporate and public sector entities (2007-2020)



Source: Bloomberg

Figure 2. Amounts of green bond issuances per category of public sector issuers (2007-2020; € billion)



Source: Bloomberg

Figure 3. Distribution of Regional Green Bond Issuances Across Public Sector Typologies