Green vs. Social Bond Premium*

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Abstract

While responsible investors consider that the environmental and social pillars are highly interconnected when implementing ESG and climate strategies, our research shows that the green and social bond markets are not integrated. Indeed, we notice that the social bond premium is not positively correlated with the greenium. On the contrary, we found a negative long-term relationship between the two premia. If we consider a dynamic analysis, we observe that the premia are highly time-varying. On average, the greenium is about -3 bps while the social bond premium is not significant and close to zero. These results indicate a behavioral difference between the primary and secondary markets. This is particularly true for social bonds that had a positive premium last year. More generally, the level of these two premia (especially the social bond premium) are a long way from reflecting the major concerns about a just transition to a low-carbon economy, and the financing dimension of net zero policies.

In this research, we also highlight the differences between green and social preferences in terms of bond pricing. First, there is a difference between green and social projects when they are financed in euros or other currencies. Clearly, non-euro projects are subject to a higher premium. We also observe that the level of the greenium is related to the credibility of the green project. In line with other academic studies, we confirm that certification, external review and the SDG dimension impact the greenium as expected by the signal theory. On the contrary, it is more difficult to understand the pricing in the social bond market since empirical relationships between the social bond premium and extra-financial factors are missing or seem counter intuitive. Therefore, we can assume that investors consider social bonds to be more conventional instruments than green bonds.

Keywords: Sustainability, green bond, social bond, ESG, climate risk, risk premium, greenium, preferences.

JEL classification: G12, Q5.

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1 Introduction

Over the last decade, financial instruments incorporating environmental, social and governance (ESG) aspects have emerged. For instance, in the sustainable fixed-income market, green, social and sustainability (GSS) bonds are a legitimate option when it comes to reaching net zero ambitions and strengthening sustainable development. Designed to deliver a positive outcome in terms of social and environmental aspects, these bonds dedicate the proceeds to supporting sustainable projects. By investing in climate-related securities, investors are willing to help achieve net zero ambitions and, more broadly, to finance mitigation and adaptation measures. In particular, green bonds have taken the lead in the sustainable fixed-income market, because climate change has become the top priority for financial institutions, supervisors, investors and policymakers in recent years. Meanwhile, environmental matters cannot completely outshine social topics since they are increasingly material for investors and interconnected with environmental topics and the just transition issue. Following the spillover of the covid-19 pandemic, we have observed significant development of social bonds, which can be seen as products analogous to green bonds that are dedicated to financing social projects.

The development of the sustainable fixed-income market has been boosted by the deployment of recent environmental and social policies, principally in developed regions. The adoption of the Inflation Reduction Act (IRA) in 2022 by the United States brings the entire economy into a transition framework. This law aims to mobilize funding to principally invest in energy and climate change topics, but also to reduce the deficit through the tax scheme and subsidized care system. This policy is the most ambitious plan[1] to tackle climate change to date while keeping an important social dimension. Across the Atlantic, Europe has also unveiled a strategic plan known as REPowerEU to support the transition. Accelerated by the war in Ukraine, the aim of the policy is to organize the transition by diversifying energy sources, increase energy savings and accelerate the deployment of renewable energy solutions to replace fossil fuels in homes, industry and power generation[2]. On the social front, the European Commission dedicated a financial program, Support to mitigate Unemployment Risks in an Emergency (SURE), to mobilize financial resources to tackle the economic and social consequences of the covid-19 pandemic in Member States. The support specifically targets safeguarding employment and the health industry, providing financial assistance by granting loans on favorable terms[3]. We believe that these kinds of policies will be able to increase issuance and drive investors' interest in use of proceeds bonds. Therefore, the interaction between the implementation of environmental or social policies and the market sentiment toward those instruments should be considered.

In this research, we omit the sustainability bond market, which is more heterogenous than the social bond market although its current growth makes it as a competitor of this last one. Strictly speaking, a social bond can be seen as a sustainability bond without a climate change objective. In this case, the market of social bonds cannot be seen as an extension of the market of green bonds. Indeed, social bonds are related to the concept of sustainable economic growth, but this form of growth is different from the concept of green economic growth. In this study, we will see that the ambiguity between these two instruments (social bond vs. sustainability bond) can explain some results related to investors' preferences when they consider social bonds.

[1] The program foresees investments of $369 bn in environmental topics and an additional $64 bn in access to care.

[2] The plan is estimating an additional investment of €210 bn between 2023 and 2027.

[3] The EU has provided around €98.4 bn in back-to-back loans. In this framework, the European Commission issues bonds and send the proceeds directly to the beneficiary country on the same terms that it received (i.e., interest rate and maturity) to finance social projects.

Investors' craving for sustainable debt instruments is directly linked to whether the green/social label influences the price that investors are willing to pay for a bond. In other words, we may wonder whether investors are willing to accept a lower yield spread for a sustainable bond relative to a conventional bond with the same characteristics. Much has been written to document this potential premium on green bonds, known as the *greenium*. Since academics have studied this phenomenon in different countries, over different periods and using distinct methodologies, one size does not fit all. Some studies report green bonds trading at a significant negative premium (i.e., at lower yields) than regular bonds (Preclaw and Bakshi, 2015; Ehlers and Packer, 2017; Partridge and Medda, 2018; Bour, 2019; Gianfrate and Peri, 2019; Nanayakkara and Colombage, 2019; Zerbib, 2019; Ben Slimane *et al.*, 2020; Fatica *et al.*, 2021; Baker *et al.*, 2022). While others support the idea of nonexistent premium (Ostlund, 2015; Hachenberg and Schiereck, 2018; Hyun *et al.*, 2020), Karpf and Mandel (2018) and Bachelet *et al.* (2019) find a positive spread between green and conventional bonds. We understand reasonably that the size and the persistence of the greenium depends on several factors such as the market (primary or secondary), the type of issuers (supranational, municipals, financials, corporates, etc.), the market universe, the rating of the issuer (both financial and extra-financial ratings), the currency, the period and the method used to assess the relationship[4].

In spite of a growing interest in the green bond market, few studies have focused on the social bond market and highlighted the dynamics of a potential premium. This is mainly due to the novelty of the product in the market[5], which can justify the small outstanding amount of issued securities. To the best of our knowledge, only two recent studies have performed the analysis. The first study conducted by Scatigna *et al.* (2021) found a negative social premium of -12 bps at the issuance date, corresponding to a credit rating upgrade of about 1 to 1.5 notches. They also advocated the critical role of currency in determining the social premium. While the effect is significant on euro- and dollar-denominated securities, the result does not hold for other currencies. The second study focused on the secondary market. Torricelli and Pellati (2023) tested the existence and the determining factors of the social bond premium. They found a small but positive social bond premium of 1.24 bps. They advocated large disparities in the premium based on sector and currency characteristics, and concluded that differences in volatility and liquidity were significant determining factors of the yield spread.

In this study, we focus specifically on social and green bonds. Beyond the interest in estimating the size of the social bond premium in the secondary market over time, we will go one step further by exploring the relationships between the green and social bond premia. Using panel regression models, we are willing to test the financial and extra-financial factors that determine the premia given market segmentation. This analysis means we can directly spot the differences between investors' green and social preferences in terms of bond pricing.

This research paper is organized as follows. In Section Two, we present the sustainable fixed-income market. In particular, we define green and social bonds and study their recent development. Section Three is dedicated to the calculation of the premium. For that, we consider two computation methods: a top-down approach based on portfolio replication and a bottom-up approach performed at the individual bond level. We further analyze the dynamics and the relationship between the two premia. In Section Four, we investigate the determinants of the premia and analyze the implicit preferences of the investors. Finally, we discuss the results and draw some conclusions in Section Five.

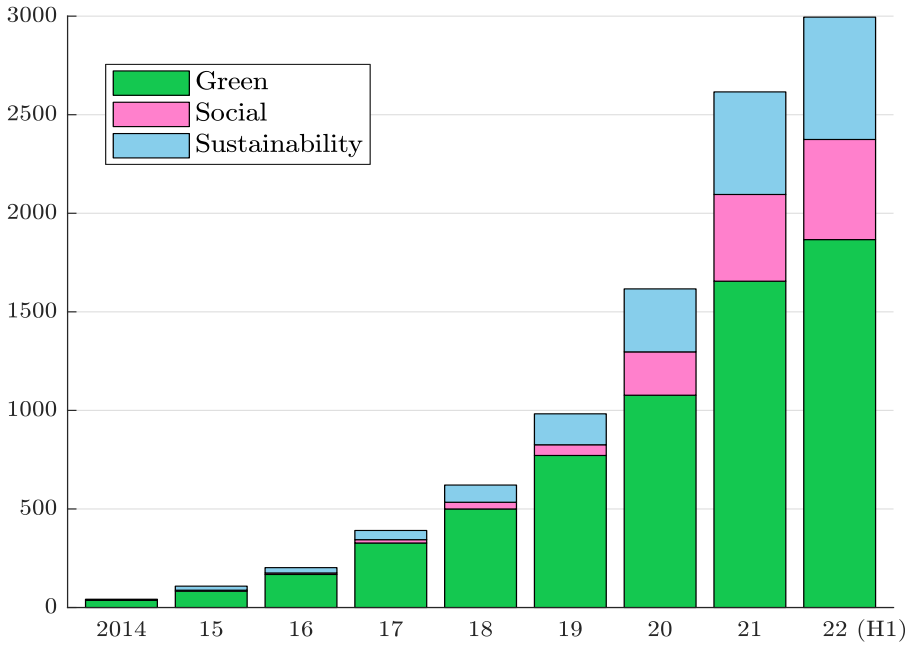
[4]See MacAskill *et al.* (2021) for a complete literature review on the greenium.
[5]The first social bond was issued in 2015 compared to 2008 for the first green bond.

2 The sustainable fixed-income market

2.1 An overview of the market

Use of proceeds bonds arise as tailored instruments to support sustainable economic development. In order to reach ambitious objectives such as net zero commitments and the sustainable development goals (SDGs), these instruments are viewed as an expedient way to contribute to their achievement by allocating capital to key matters. On the initiative of the International Capital Market Association (ICMA), the quick development of the market has been possible thanks to the progress made in providing standards issuance guidelines. ICMA provided the Green Bond Principles (GBP) in 2014 and the Social Bond Principles (SBP) in 2017. In Figure 1, we illustrate the cumulative issuance of green, social and sustainability bonds. Unsurprisingly, green bonds lead the market with more than 11 000 issued securities. According to the Climate Bond Initiative (CBI), the size of the green bond market has continuously expanded over the years to reach $1.9 tn as of June 2022.

Figure 1: Notional outstanding of green, social and sustainability (GSS) debt (in $ bn)



Source: https://www.climatebonds.net/market/data.

We notice a more nuanced picture of social debt instruments. Indeed, the social bond market is still at an early stage with a market size of roughly $500 bn at the end of June 2022, representing barely 17% of the GSS market. However, in a global economic context weakened by the shockwave of the covid-19 pandemic, social bonds have been expressly attractive to contain economic spillovers. According to CBI, the number of issued securities has increased by 270% between 2019 and 2021. The quick increase in issuance to face the covid-19 outbreak has shown the willpower of this instrument to address the social emergency. This was made possible thanks to the launch of the European SURE program in 2020. The program was the most ambitious social bond scheme from which 19 Member States received financial support. However, social bonds seem to lose momentum, and the

number of issuances is affected by the end of the SURE program[6]. We observe that the social bond market will not catch up the issuance volume of green bonds in the shorter medium-term, even if social distresses caused by the health crisis will be long-lasting.

A third sustainable fixed-income security is the sustainability bond. This is a debt instrument targeting projects or activities in line with both environmental and social topics. Basically, sustainability bonds are related to social projects that may have environmental co-benefits, and vice-versa. According to CBI, the cumulative issuance of sustainability bonds stands at $620 bn at the end of June 2022, which marginally overtakes the cumulative issuance of social bonds.

2.2 The green bond market

2.2.1 Definition

The green bond label is attributed to "*any type of bonds instrument where the proceeds will be exclusively applied to finance or re-finance in part of full new and existing eligible green projects and which are aligned with the four core components of the Green Bond Principles*" (ICMA, 2021a). To clarify the issuance of green bonds and to provide investors with the prerequisite information to assess the positive impact of the instrument, ICMA proposes a set of four core guidelines. Those guidelines also ensure market integrity to try avoiding greenwashing. The first and certainly the most essential guideline of the GBPs defines a list of eligible projects to which the proceeds have to be allocated. Here is an overview of the main projects:

- Energy: expand the production, the transmission of renewable energy as well as accelerate energy efficiency;
- Sustainable infrastructure: development of clean transportation and clean buildings;
- Biodiversity: conservation of terrestrial and aquatic biodiversity;
- Climate change: development of adaptation and mitigation solutions;
- Sustainable industry: prevention and control over pollution;
- Resources: preserve living natural resources and sustainable management of land use, water and wastewater;
- Circular economy: improvement of the production and the processes of certified eco-efficient products.

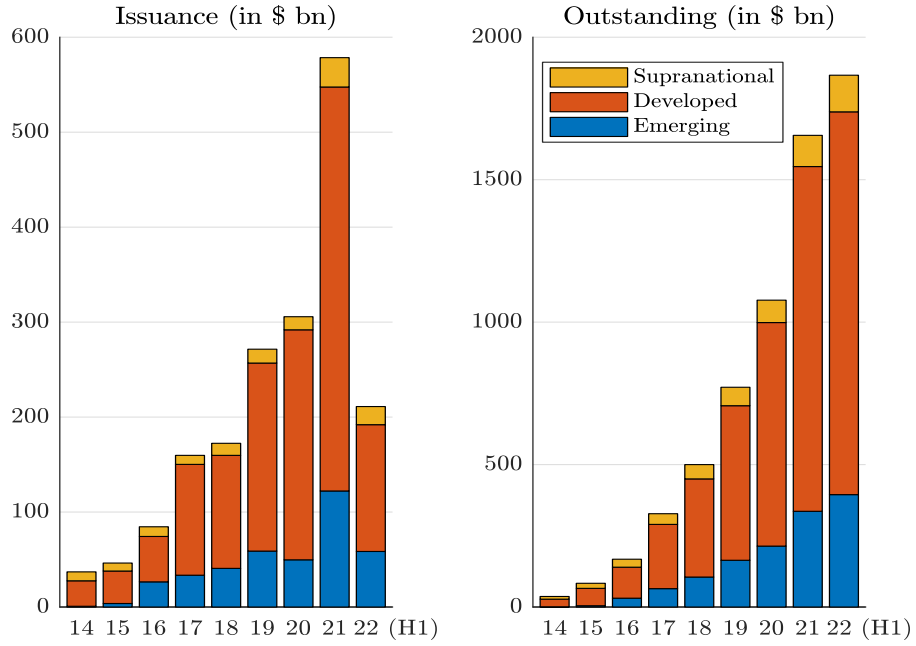
The second guideline establishes that the process for project evaluation and selection must be transparent, meaning that the issuer should be clear on the environmental goal as well as the process used to fit the project within the list of eligible projects. It is generally supplemented by an external reviewer testify to the rigor and the transparency of the process. The third guideline recommends disclosing how proceeds are managed. Finally, the fourth guideline promote reporting standards. The annual report should include a detail of each project with its proceeds allocation. The reporting guideline advocates the necessity to use qualitative and quantitative performance indicators, generally refereed as key impact indicators (KPI), to justify the concrete impact of the project. For instance, mainstream KPIs to assess green projects are the number of annual tonnes of avoided CO_2, the annual energy savings in MWh, the number of hectares of restored forest land, the distance to public transportation and the number of people with access to improved sanitation facilities (ICMA, 2022a).

[6]The SURE program was concluded at the end of 2022. The complete timeline is available at: https://economy-finance.ec.europa.eu/eu-financial-assistance/sure_en.

2.2.2 The market of green bonds

According to CBI (2022), the green bond market has expanded with an average growth rate of 54% in the last five years. At the end of 2021, the cumulative number of issuers reached 2 045 for a pool of 9 886 instruments issued across 80 countries. In Figures 2–5, we report some statistics of the green bond market. For each figure, we provide the annual amount issued in the left panel, and the notional outstanding in the right panel. If we consider Figure 2, 72% of the green bond market is located in developed markets. Emerging markets represent 21% of the outstanding amount. This proportion has been relatively stable since 2018 after a sharp increase between 2015 and 2017. Figure 3 shows that the green bond market is led by European issuers, representing more than $860 bn in cumulative issuance and 46% of the market in the first half of 2022. Asia-Pacific is the second largest region in green bond issuance, notably thanks to the large amount issued by China ($199 bn at the end of 2021), positioning this country as the second largest issuer behind the United States[7]. Supranational issuers are less visible than expected, with a market share of less than 7%. Considering the issuer type breakdown given in Figure 4, we acknowledge the leading position of the private sector with a market share of around 56.6% (34.1% for financials and 22.5% for corporates). Sovereigns issuers are behind with a market share of approximately 30%. We complete this analysis by the distribution of the green debt by use of proceeds in Figure 5. The bulk of the green bond market is contained in a handful of sectors. Indeed, more than 80% are directed toward energy, buildings and transport projects. Finally, more than 70% of green bond issuance is up to $500 mn and 63% of green bonds have a maturity of up to 10-years (CBI, 2022).

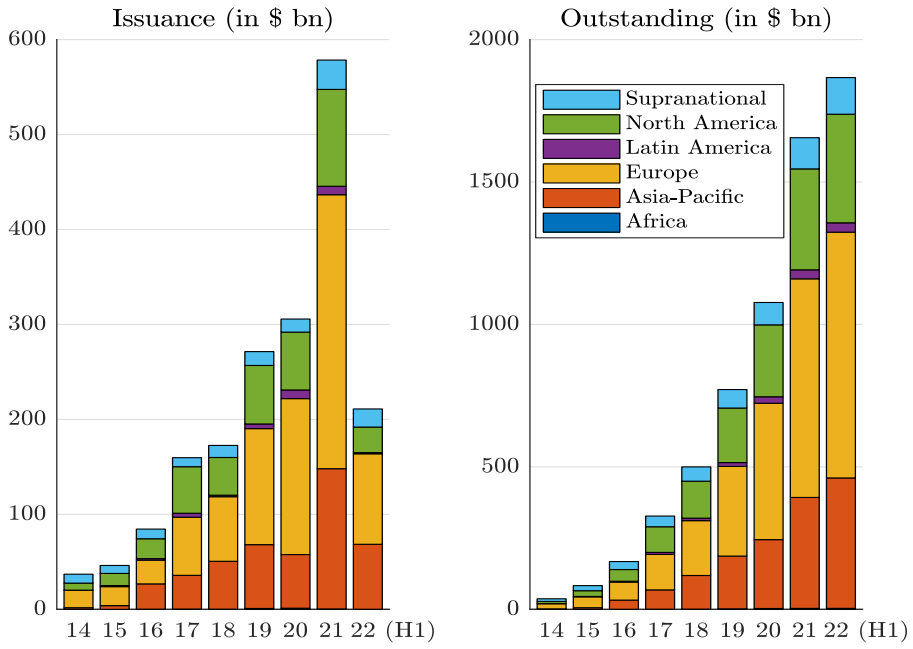
Figure 2: Issuance and notional outstanding of green bonds by market type



Source: https://www.climatebonds.net/market/data.

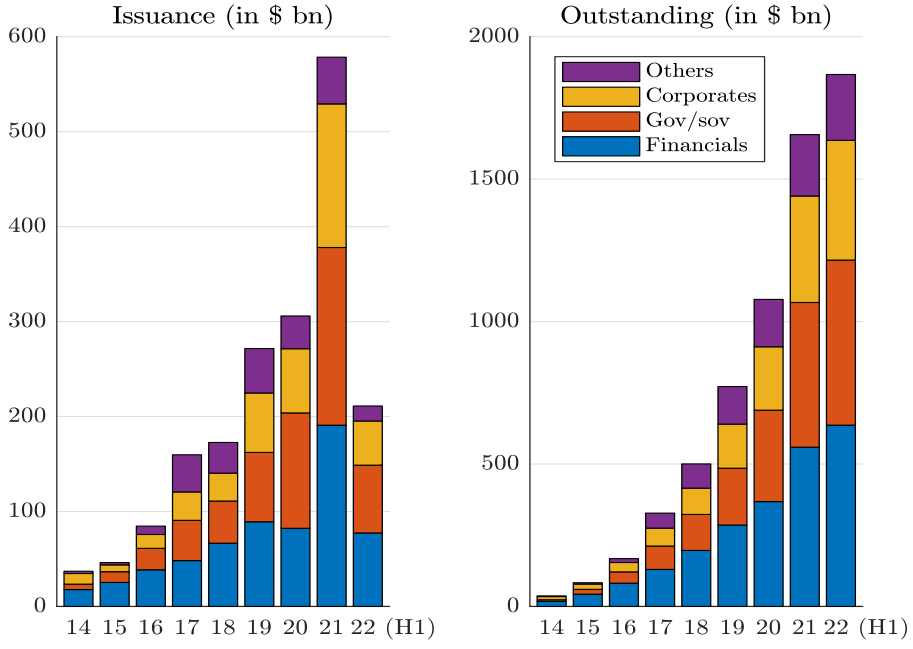
[7] They issued $304 bn of green bonds at the end of 2021.

Figure 3: Issuance and notional outstanding of green bonds by region



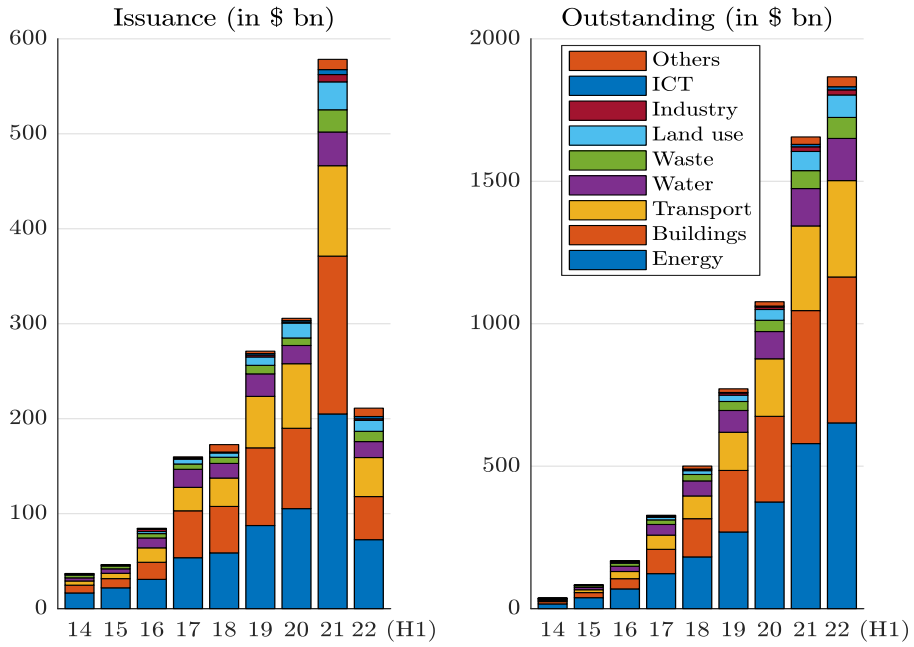
Source: https://www.climatebonds.net/market/data.

Figure 4: Issuance and notional outstanding of green bonds by issuer type



Source: https://www.climatebonds.net/market/data.

Figure 5: Issuance and notional outstanding of green bonds by use of proceeds



Source: https://www.climatebonds.net/market/data.

2.3 The social bond market

2.3.1 Definition

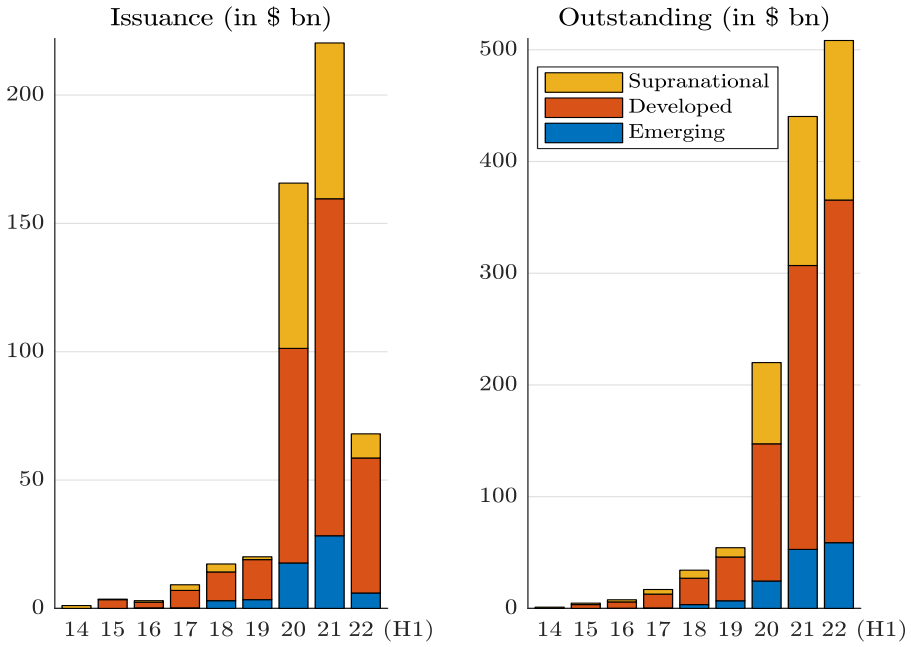
The social bond label is attributed to "*any type of bonds instrument where the proceeds will be exclusively applied to finance or re-finance in part of full new and existing eligible social projects and which are aligned with the four core components of the Social Bond Principles*" (ICMA, 2021b). The four components of the Green Bond Principles hold for the Social Bond Principles. The eligible social project has to address or mitigate the specific social issue and focus, if possible, on a target population. The projects are generally part of social milestones such as:

- Basic infrastructure: access to affordable basic infrastructure (clean drinking water, sewers, sanitation, transport and energy);
- Essential services: access to essential services (health, healthcare, vocational training, education and financial services);
- Affordable housing: access to affordable housing;
- Employment: reduce unemployment and increase support for microfinance programs and founding small and medium-sized enterprises;
- Food security: access to safe, nutritious and sufficient food; resilient agricultural practices, food loss and waste;
- Empowerment: reduce income, gender, resources, opportunities and assets inequalities.

An eligible project can target a specific population such as households living below the national poverty line, marginalized communities, people with disabilities, migrants, underserved, under-educated, unemployed, gender minorities, aging population and youth. The

target population corroborates the positive social impact of the investment. For the measure of impact reporting, ICMA provides a set of KPIs, closely related to the SDGs. Some examples are the number of hospital beds, the number of patients benefiting from healthcare or medical treatment, the share of under-served tenants, the number of textbooks and teaching materials supplied, the number of people provided with access to financial services and the share of disabled people employed (ICMA, 2022b). Nevertheless, the impact reporting of social projects often suffers from a large amount of qualitative and intangible information that could be difficult to understand.

Figure 6: Issuance and notional outstanding of social bonds by market type

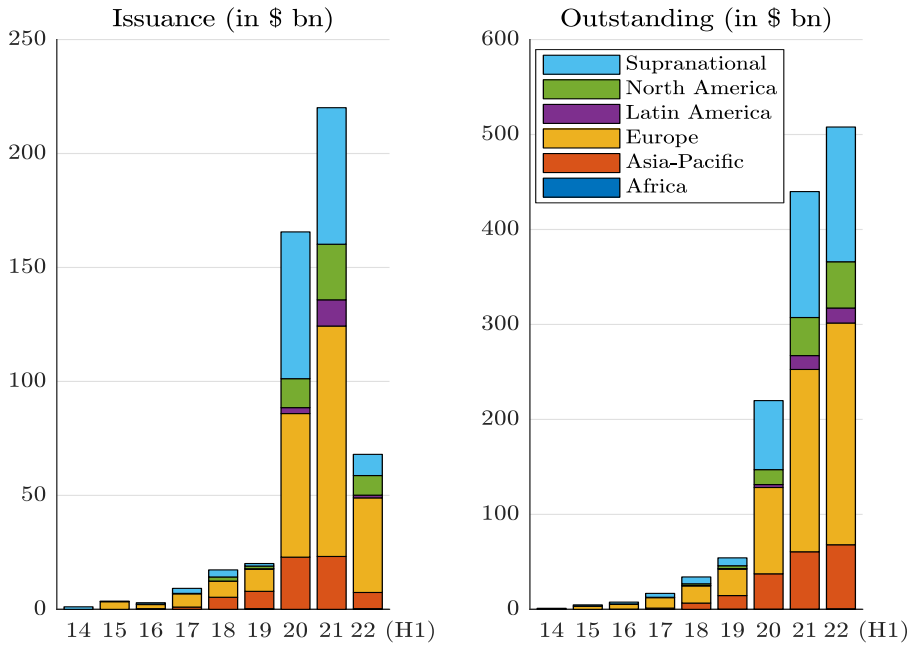


Source: https://www.climatebonds.net/market/data.

2.3.2 The market of social bonds

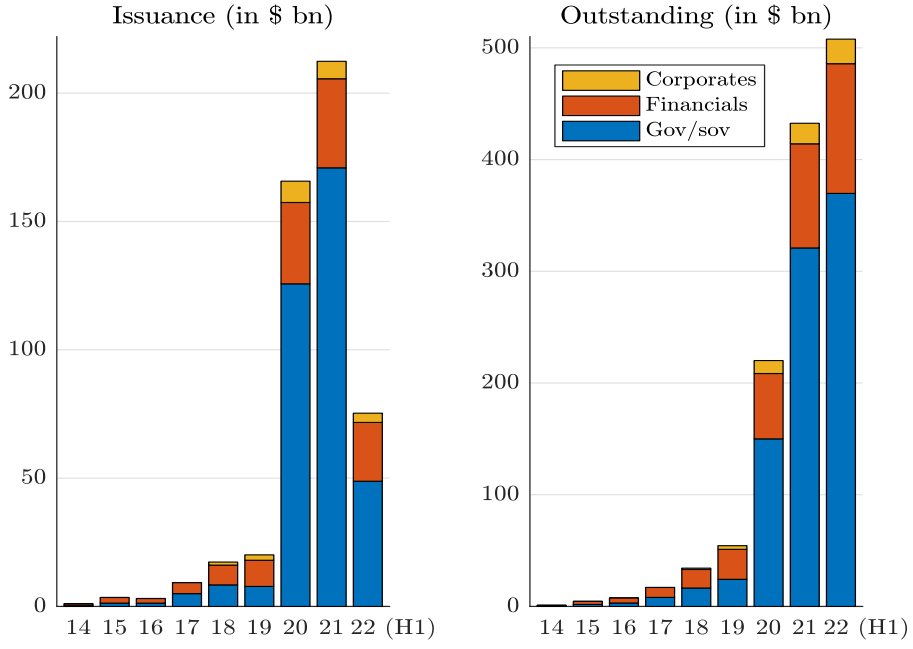
Overall, 861 entities have issued more than 3 470 social bonds across 44 countries (CBI, 2022). Beyond the smaller size, the social bond market differs in many aspects with respect to the green bond market. First, supranational issuers are more represented, with a cumulative market share of approximately 30% (Figure 6). Second, Asia-Pacific and North America are less represented in the social bond market (respectively 13.3% and 9.6% versus 24.5% and 20.4% in the green bond market), while the proportion of European issuers is very close with a level of 46% (Figure 7). Third, most of sovereign bond issuance is led by government and sovereign entities, totaling around 73% of the market (Figure 8). This market segmentation occurred between 2019 and 2020, when the market share of government and sovereign issuers recorded a sixfold growth, notably due to the launch of the SURE European program. As a consequence, the market of social debt is disproportionately dominated by developed countries and most of social bonds are denominated in euros (about 59% of the market). Finally, the bond structure differs from green bonds, since most of social bonds have a maturity below ten years and a notional lower than $500 mn (CBI, 2022).

Figure 7: Issuance and notional outstanding of social bonds by region



Source: https://www.climatebonds.net/market/data.

Figure 8: Issuance and notional outstanding of social bonds by issuer type



Source: https://www.climatebonds.net/market/data.

3 Green and social bond premia

3.1 Computation of the premium

We define the premium as the difference in yield between target (whether it is a green or social) and regular bonds having the same risk characteristics. The premium is measured in bps. Although it can be computed at the issuer/bond level, it is more common to estimate the premium for a given market segment. For instance, we can compute the greenium for the energy sector or the social bond premium for EUR-denominated bonds (Ben Slimane *et al.*, 2020).

3.1.1 Methodology

There are two main approaches to estimating the green bond premium:

1. The bottom-up matching approach consists in computing the yield difference at the bond level. This means that we compare the green bond of an issuer with a synthetic conventional bond of the same issuer having the same characteristics in terms of currency, seniority and duration (Zerbib, 2019).

2. The top-down replication approach consists in computing the yield difference at the portfolio level. The underlying idea is to consider a diversified portfolio of green bonds and replicate it with a portfolio of conventional bonds. The objective of the replication process is to avoid biases in terms of currency, sector, credit rating, maturity, etc. Therefore, the greenium is the difference between the yield of the green bond portfolio and the yield of the replication portfolio.

We adopt the same approaches to social bonds.

In the bottom-up approach, we first filter all the conventional bonds, which have the same issuer, currency, and seniority of the target bond TB. Then, we select the two conventional bonds CB_1 and CB_2 which are the nearest in terms of modified duration (MD):

$$\left|\text{MD}\left(\text{TB}\right) - \text{MD}\left(\text{CB}_j\right)\right|_{j\neq 1,2} \geq \sup_{j=1,2}\left|\text{MD}\left(\text{TB}\right) - \text{MD}\left(\text{CB}_j\right)\right|$$

Finally, we perform the linear interpolation/extrapolation of the two yields $y\left(\text{CB}_1\right)$ and $y\left(\text{CB}_2\right)$ such that the modified duration of the synthetic conventional bond is exactly equal to the green bond's modified duration. For instance, by assuming that $\text{MD}\left(\text{CB}_1\right) \leq \text{MD}\left(\text{CB}_2\right)$, the yield of the synthetic conventional bond is:

$$y\left(\text{SCB}\right) = y\left(\text{CB}_1\right) + \frac{\text{MD}\left(\text{TB}\right) - \text{MD}\left(\text{CB}_1\right)}{\text{MD}\left(\text{CB}_2\right) - \text{MD}\left(\text{CB}_1\right)}\left(y\left(\text{CB}_2\right) - y\left(\text{CB}_1\right)\right)$$

This computation is done for each target bond TB_i and the greenium is equal to the average of the yield difference:

$$\boldsymbol{\mathcal{P}} = \frac{1}{n}\sum_{i=1}^{n}\left(y\left(\text{TB}_i\right) - y\left(\text{SCB}_i\right)\right)$$

In the top-down approach proposed by Fender *et al.* (2019), we consider a portfolio $w = (w_1, \ldots, w_n)$ of n target bonds. Then, we perform a clustering analysis by considering the 4-uplets (Currency × Sector × Credit quality × Maturity). Let $\left(C_h, S_j, R_k, M_l\right)$ be an observation for the 4-uplet (e.g. EUR, Financials, AAA, 1Y-3Y). We compute its weight:

$$\omega_{h,j,k,l} = \sum_{i\in\left(C_h,S_j,R_k,M_l\right)} w_i$$

The premium is then defined as the weighted excess yield:

$$\mathcal{P} = \sum_{h,j,k,l} \omega_{h,j,k,l} \left(y_{h,j,k,l}\,(\text{TB}) - y_{h,j,k,l}\,(\text{CB}) \right)$$

where $\omega_{h,j,k,l}$ is the weight of the cluster $\left(C_h, S_j, R_k, M_l\right)$ in the target portfolio, $y_{h,j,k,l}\,(\text{TB})$ is the yield of the cluster in the target portfolio and $y_{h,j,k,l}\,(\text{CB})$ is the yield of the cluster in the benchmark portfolio. Generally, this approach is applied to a green bond index, implying that the target portfolio is the green bond index and the benchmark portfolio is the parent bond index.

3.1.2 Data

We follow Ben Slimane *et al.* (2020) and use the Bloomberg MSCI Global Green Bond Index and its constituents to estimate the greenium. We also pick conventional bonds from the Bloomberg Global Aggregate Index. We assess the social bond premium by considering the bonds flagged by Bloomberg as social bonds in the Bloomberg Global Aggregate Index and select conventional bonds from the same global index. An analysis of bottom-up data is provided in Appendix A.2 on 31. For reasons of historical data depth, we use the ICE Social Bond Index and ICE BofA Global Broad Market Index as portfolio and benchmark in the top-down approach. Bottom-up data are retrieved weekly, while we collect monthly data for the top-down approach.

3.1.3 Empirical results

Using the previously detailed methodologies, we provide some estimates of the bond premia. In Figures 9 and 10, we illustrate the evolution of the green and social bond premia using both the top-down and bottom-up approaches. Even if the two methodologies provide closely related estimates, we observe some polarized patterns at different time periods. For instance, from April 2019 to the end of 2020, the social bond premium estimated with the top-down approach shows a decreasing trend while the bottom-up approach reckons an increasing trend. Similarly, during the market panic in 2020, the green bond premium tends to sharply decrease in the top-down approach while positively spiking in the bottom-up approach. Overall, we acknowledge that the estimates of the top-down approach are smoother than the bottom-up approach due to fewer points over the period. Yet, we observe a distinct structural pattern between the green and social bond premia. Omitting the market turbulence between March and May 2020, the social bond premium is between -2.5 and 5 bps while the green bond premium oscillated between -7.3 and -0.6 bps. Moreover, we also recognize a more volatile trend in the social bond premium compared to the greenium. Based on the bottom-up approach, the green bond premium has a volatility of 0.8 bps while the social bond premium volatility is twice and equal to 1.6 bps.

Table 1: Average green and social bond premia (in bps)

Year	Top-down		Bottom-up	
	Green	Social	Green	Social
2019	−4.2	2.8	−2.2	−1.3
2020	−5.3	0.5	−2.3	−1.1
2021	−3.0	−0.1	−2.8	−0.2
2022	−3.2	1.5	−3.7	1.5
2019–2022	−3.9	1.2	−2.8	−0.2

Figure 9: Top-down estimates of the green and social bond premia (in bps)

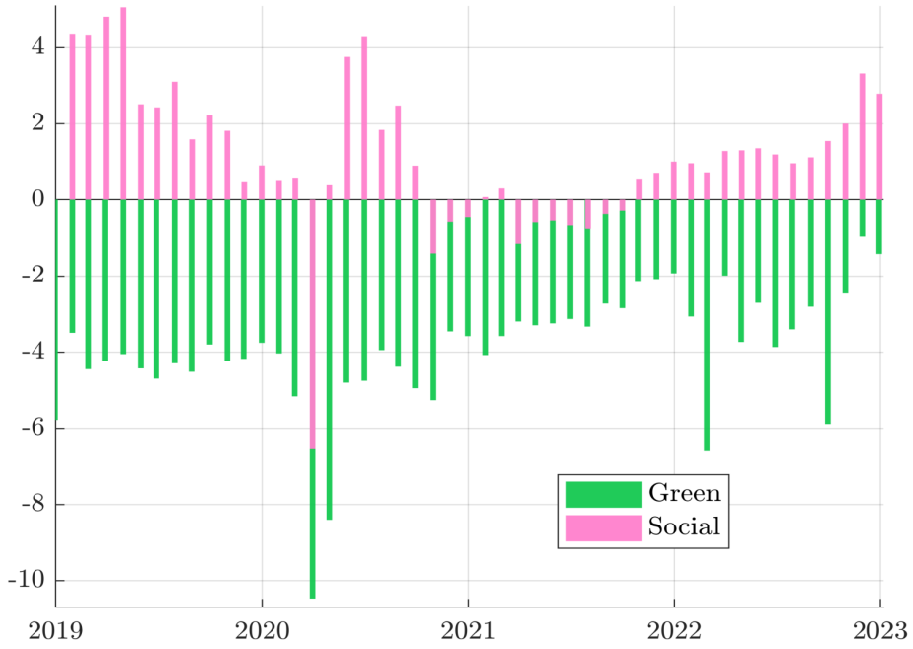
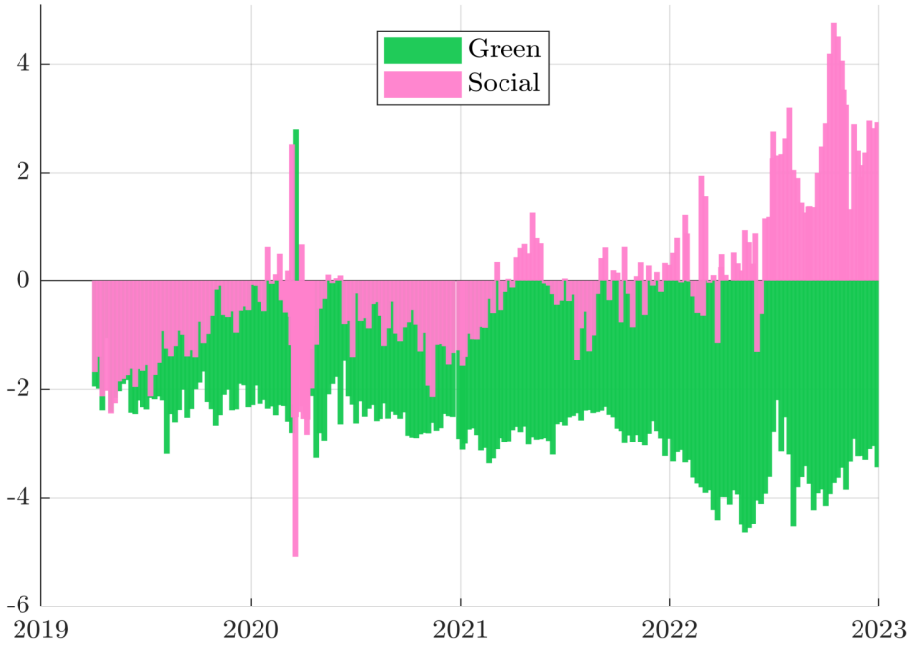


Figure 10: Bottom-up estimates of the green and social bond premia (in bps)



In Table 1, we compute the annual average premia by year. If we consider the top-down approach, the magnitude of the greenium has decreased these last two years. Except for the year 2021, the social bond premium is positive. The results based on the bottom-up approach are somewhat different. The bottom-up greenium is generally higher than the top-down greenium. On the contrary, the social bond premium is generally lower than in the bottom-up premium, thus leading to a negative premium. Nevertheless, the year 2022 is an exception with a positive social bond premium of 1.5 bps on average.

Remark 1. *Throughout the rest of the study, we will only consider the results determined by the bottom-up approach since it offers a more granular ground for empirical analysis*[8]*. Indeed, computed at the individual bond level, we have a number of features and dimensions that would be interesting to test in econometric models. Nevertheless, if possible, some results will also be tested on premia computed with the top-down approach for robustness validity.*

In Figure 11, we illustrate the evolution of the green bond premium[9]. The overall trend of the yield spread between green and conventional bonds on the secondary market is negative, meaning that, all else being equal, investors are willing to forsake a small share of returns in exchange for environmental benefits[10]. In the EUR-denominated bond market, the greenium has been consistently negative over the years, with an average spread of −2.3 bps (Table 2). While the spread between green and conventional bonds denominated in dollars also supports the presence of a greenium[11], we notice a positive spike during the covid-19 crisis[12] in March 2020. During this period, green debt issued in USD traded at lower prices than conventional bonds on average, but the premium quickly returned to be negative. We observe a similar pattern for EUR-denominated bonds, but the greenium did not turn positive.

Table 2: Average green and social bond premia (in bps)

Year	Green				Social			
	AC	EUR	USD	Non-EUR	AC	EUR	USD	Non-EUR
2019	−2.2	−1.3	−4.5	−3.3	−1.3	−1.6	2.6	−0.2
2020	−2.3	−2.0	−3.2	−2.6	−1.1	−1.2	−5.8	−0.5
2021	−2.8	−2.2	−4.1	−3.5	−0.2	−0.7	2.4	1.2
2022	−3.7	−3.5	−5.5	−3.9	1.5	0.3	7.9	4.2
2019–2022	−2.8	−2.3	−4.3	−3.3	−0.3	−0.8	2.6	1.1

In Figure 12, we illustrate the evolution of the social bond premium. As described previously, the social bond market is extensively represented in Europe. Thus, we show the breakdown of the social bond premium between securities denominated in euros and other currencies. Overall, we notice fragmented yield estimates between social and conventional bonds in the secondary market. In the long run, the premium is close to zero and equal to −0.3 bps on average (Table 2). However, we notice that it was negative and equal to −0.9 bps between 2019 and 2021. Since the beginning of 2022, the social bond premium has been in positive territory (1.5 bps on average). However, we observe large differences between social bonds denominated in euros and other currencies. During this last period, the

[8] Moreover, the bottom-up approach is more adequate with the definition of a bond premium, while the top-down approach determines the carry premium between two portfolios.

[9] We only report the negative part of the chart, because the positive part concerns few trading days that are mainly located during the covid-19 crisis.

[10] The average greenium is equal to −2.8 bps during the study period (see Table 2).

[11] The average greenium is equal to −4.3 bps for USD-denominated bonds (see Table 2).

[12] The maximum value was observed at 20 March 2020 and equal to +16 bps.

Figure 11: Evolution of the greenium with respect to the currency denomination (in bps)

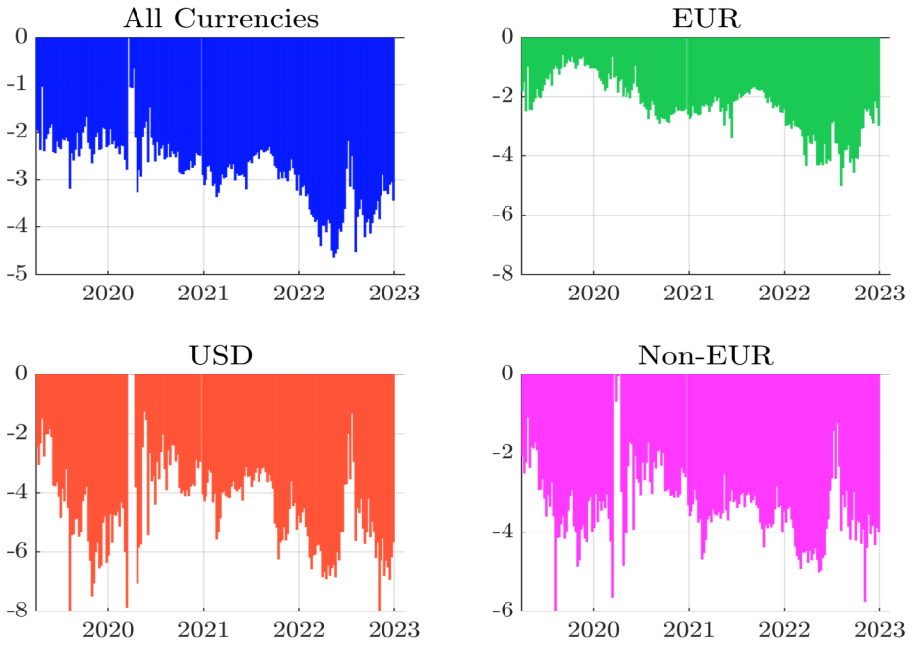
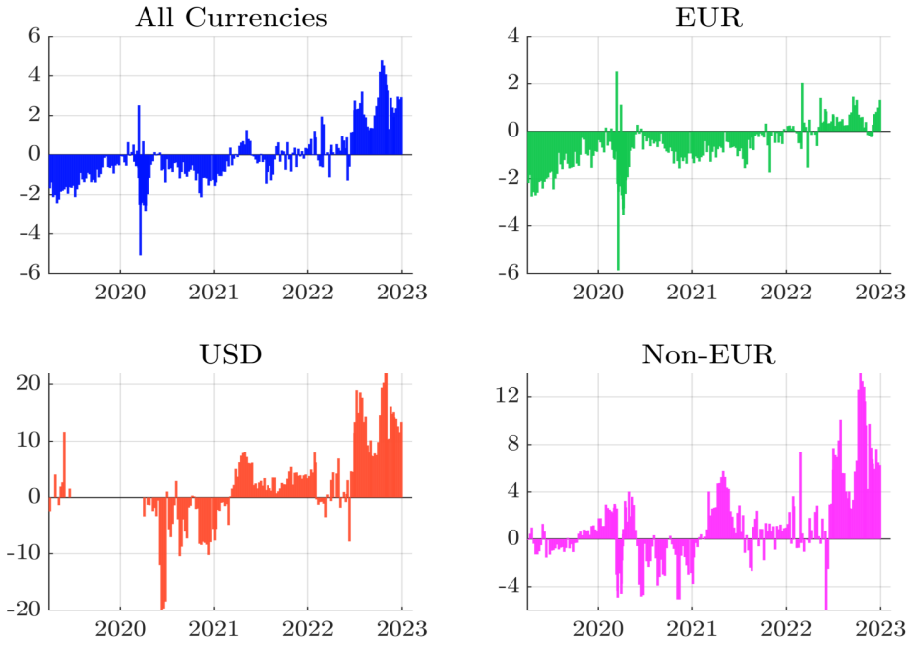


Figure 12: Evolution of the social bond premium with respect to the currency denomination (in bps)



average premium is 4.2 bps for other currencies, and equals 0.3 bps for EUR-denominated social bonds. More generally, the global social bond premium tends to be pushed upwards by non-euro denominated bonds. For instance, the frequency of observing a higher premium for other currencies compared to euro is equal to 77% during the study period. The gap is close to 2 bps (−0.8 bps for euro versus +1.1 bps for other currencies). These results suggest that, conversely to green bonds, investors are unwilling to give up returns to support social projects, especially when these projects are not located in the eurozone.

3.2 Analysis of the results

We are now focusing on the relationship between green and social bond premia in the secondary market. This part is dedicated to understanding of common and divergent factors between the two instruments. On the one hand, if we assume that the green bond market is leading the overall trend in the market of use of proceeds bonds, we might find a potential long-term relationship between the two series. This correlation pattern could result in the cointegration between the greenium and the social bond premium. On the other hand, the social bond market is different from the green bond market in many aspects, which could limit the similarity level between the two premia.

3.2.1 Static analysis

We first undertake the analysis at the global level, without making any assumptions about their respective differences. The idea is to unveil the overall relationship between the two premia, either in price or relative difference. This naive viewpoint is likely to be biased by several factors that we must control for. Therefore, in a second step, we will segment the analysis by considering the different market characteristics to provide a more accurate perception of the relationship.

Global analysis In Table 3, we estimate the correlation coefficients by considering the weekly time series of green and social bond premia. We provide both the Pearson linear correlation and the Spearman rank correlation coefficients. We consider the premia absolute level and the weekly relative variation. For each estimate, we also test the hypothesis of no correlation and report the corresponding level of significance[13]. We find an average Pearson correlation of −53% between the two series. This negative correlation is confirmed by the Spearman coefficient of −60%. When the raw data are differentiated, the correlation is lower. The Pearson coefficient is −28%, whereas the estimate is not statistically different from zero for the Spearman coefficient. When looking at the annual breakdown, we observe that the relationship is not stable over time. In particular, the correlation is positive in 2022.

Table 3: Estimated correlation in % between green and social bond premia

Series	Type	2019	2020	2021	2022	2019–2022
Absolute	Pearson	−18.3	−33.8**	−14.1	38.2***	−53.4***
	Spearman	−14.8	0.0	−14.4	41.9***	−59.6***
Variation	Pearson	0.4	−70.1***	−5.3	15.0	−36.5***
	Spearman	−11.9	−19.8	−1.8	13.1	−3.6

[13] ***, ** and * denote statistical significance at 1%, 5% and 10% probability levels respectively.

Remark 2. *We have computed the correlation by considering a lower frequency of the time series in order to reduce the noise. For instance, if we consider the four-week moving average of the premia*[14]*, we obtain the results given in Table 9 on page 30. We notice that they are similar at the global level.*

Issuer analysis To make a consistent comparison between the two premia, we must restrict the analysis to the most common type of issuers. Since the social bond market is substantially smaller than the green bond market, we may consider the largest common pool of issuers type in the two samples, i.e., agencies and sovereigns (AS) and supranational (SN) issuers. In Table 4 and Figures 13 and 14, we illustrate the evolution of the green and social bond premia considering these two types of issuers and notice substantial particularities. Considering the social bond market, the premium is negative between 2019 and 2022 for agencies and sovereign issuers. It turns to positive values at the end of 2022. For supranational issuers, we observe a less pronounced premia. Overall, the premium is flatter, and close to be null, even during 2022. When considering the green bond premium, we advocate a more marked greenium for supranational issuers, notably in 2019. After this period, the greenium tends to be slightly reduced. The trend is similar when we are looking at agencies and sovereign issuers, even if the greenium is irrelevant during 2019. Moreover, we also notice that these two market segments do not show any strong spikes during the market turmoil of 2020 as we observed on the aggregated premia analysis. This could reflect the less volatile nature of the premium for these two categories of issuers.

Table 4: Average green and social bond premia (in bps)

Premium	Issuer	Currency	2019	2020	2021	2022	2019–2022
Green	AS	AC	−1.2	−1.8	−2.2	−2.5	−2.0
	CORP		−3.9	−3.9	−3.8	−7.2	−4.8
	FIN		−0.8	−1.4	−2.7	−1.4	−1.6
	SN		−4.9	−2.5	−2.2	−1.6	−2.7
	SSA	AC	−2.4	−2.0	−2.2	−2.3	−2.2
		EUR	−1.2	−1.2	−1.2	−2.2	−1.5
		Non-EUR	−3.2	−2.6	−3.0	−2.4	−2.8
Social	AS	AC	−2.6	−0.9	−0.9	0.6	−0.8
	CORP		−3.2	0.5	1.4	−1.5	−0.3
	FIN		0.2	−1.3	1.3	4.8	1.1
	SN		−0.6	−0.5	−0.9	−0.2	−0.5
	SSA	AC	−1.8	−0.8	−0.9	0.3	−0.7
		EUR	−2.1	−0.9	−0.8	0.1	−0.8
		Non-EUR	0.2	−0.2	−0.7	0.9	0.0

Remark 3. *We have also reported the premium for financial issuers (FIN) and non-financial corporations (CORP). We notice that the premium is always lower for this last category than for financials, except for the year 2020 and the social premium.*

Currency analysis Besides the issuer type, another important dimension is the currency of the bonds. The case of sovereigns, supranationals, and agencies (SSA) is illustrated in Table 4. The absolute value of the premium is lower in absolute value for green bonds denominated in euros than for green bonds denominated in other currencies. For social

[14]The corresponding time series are reported in Appendix A.1.2 (Figure 15 on page 31).

Figure 13: Agencies and sovereign issuers (bottom-up premia in bps)

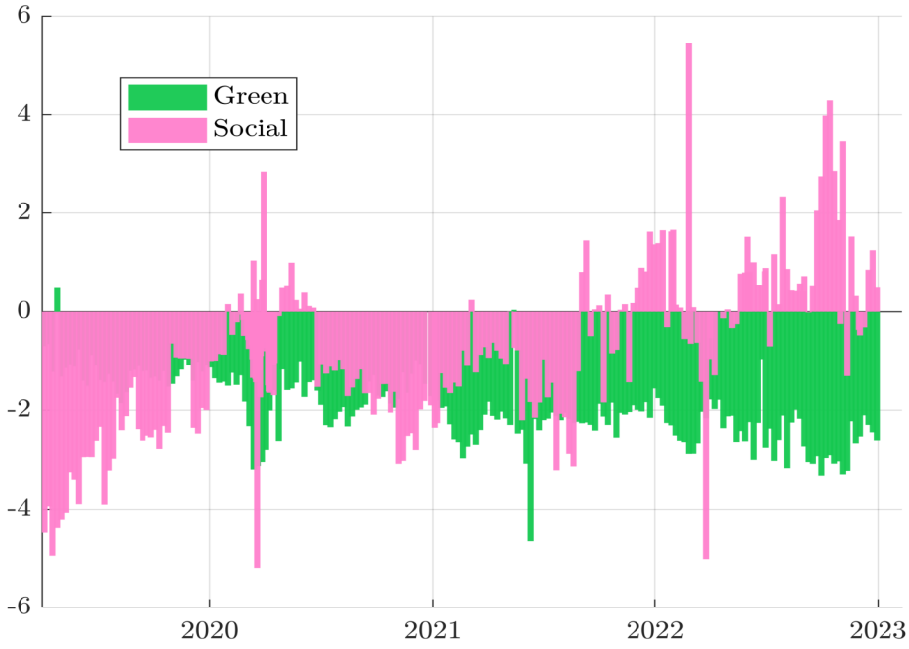
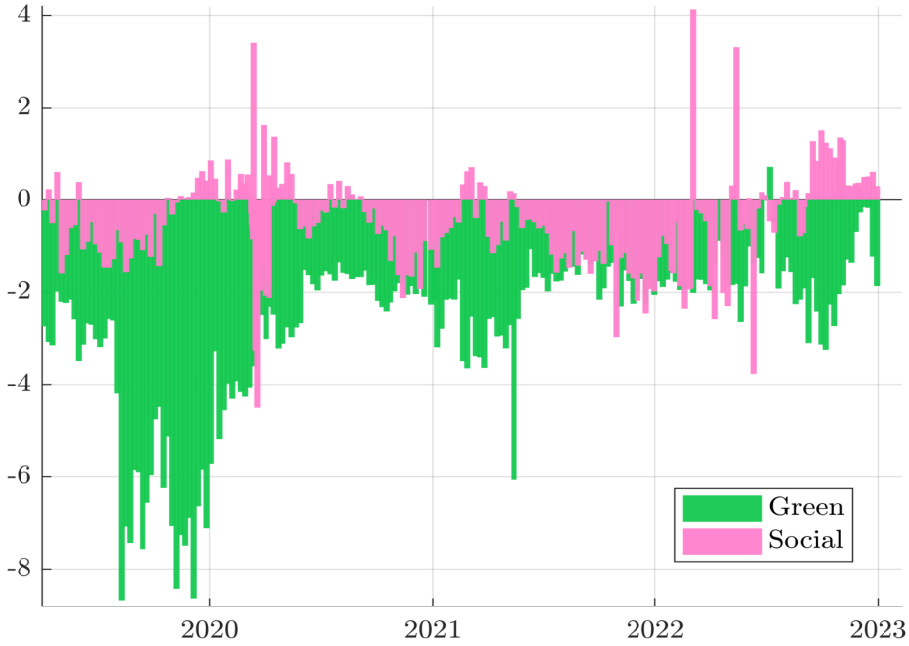


Figure 14: Supranational issuers (bottom-up premia in bps)



bonds, we obtain a contrary ordering. EUR-denominated social bonds have a lower premium than non-EUR bonds, except for the year 2022. If we perform a correlation analysis, we obtain the results given in Table 5. Correlations in level are negative while correlations in difference are positive. Nevertheless, these last ones are not significant at the 99% confidence level.

Table 5: Estimated correlation in % between green and social bond premia (SSA issuers)

	Level		Difference	
Currency	Pearson	Spearman	Pearson	Spearman
AC	-33.1^{***}	-32.7^{***}	2.8	5.2
EUR	-42.8^{***}	-47.3^{***}	13.2^{**}	9.5
Non-EUR	-20.5^{***}	-15.7^{**}	8.2	13.4^{**}

3.2.2 Dynamic analysis

The previous results show no obvious simple relationship between the green and social bond premia. To go further, we investigate the joint dynamics using the Granger causality test (Granger, 1969, 1988). The test determines if two series show causal relationships, meaning that the past values of one time series can improve the prediction of the other time series and vice versa. In Table 6, we report the test results by considering the weekly variation of green and social bond premia. We are looking if the variations of the green bond premium can cause variations of the social bond premium at some lags. Overall, the results suggest that changes in the green bond premium not help to predict the social bond premium variation. This is true if we consider the global premia (AC), the EUR-denominated premia and if we restrict the analysis to the SSA issuers. The causal relationship is statistically significant at the 95% confidence level for non-EUR denominated bonds only but at lags two and three.

Table 6: Granger causality test (Green ⇒ Social)

	AC		EUR		Non-EUR		SSA	
Lag	F-test	p-value	F-test	p-value	F-test	p-value	F-test	p-value
1	0.01	0.88	1.78	0.18	1.34	0.24	0.00	0.96
2	1.07	0.34	1.69	0.18	3.65	0.02^{**}	2.51	0.08^{*}
3	1.23	0.29	1.19	0.31	2.96	0.03^{**}	1.91	0.12
4	0.64	0.62	1.31	0.26	2.12	0.07^{*}	1.53	0.19
5	0.61	0.68	1.11	0.35	1.95	0.08^{*}	1.37	0.23
6	0.59	0.73	0.91	0.48	1.82	0.09^{*}	1.30	0.25
7	0.63	0.72	1.12	0.35	1.53	0.15	1.17	0.32
8	0.43	0.90	1.13	0.34	1.27	0.26	1.21	0.29
9	0.36	0.94	1.01	0.42	1.30	0.23	1.12	0.35
10	0.40	0.94	0.89	0.54	1.19	0.30	1.01	0.42

Remark 4. *In Table 10 on page 30, we further test if the reverse relationship exists (Social ⇒ Green). The results shed light on a potential causal relationship between social and green premia for all currencies at some lags but are inconclusive for any other sub-categories, which disapprove the relationship. Overall, we conclude that there is no relationship between the two sets of series.*

4 Green vs. social preferences

Several factors can explain the depth of the green and social bond premia in the secondary market, but two dimensions can be seen as the main contributors to the spread between target and conventional bonds. While the first dimension is associated with the traditional risk structure (or the financial characteristics) of the asset, the second dimension is more related to the extra-financial characteristics of the assets and the investor's preferences. Concerning the first component, the performance of an asset is ineluctably related to its risk level. More than any other asset class, bonds are specifically subject to idiosyncratic risks since they are generally separated into buckets (duration, rating, sector, currency, etc.). For instance, the corporate bond market is split between investment grade and high yield segments, which describe the issuer's probability of default. These financial characteristics are scrutinized by investors and should drive their expectations in the secondary market. Concerning the second component, as the sustainable bond market relies on ESG criteria, investors seek sustainable improvements on top of financial returns. As a consequence, investors' preferences depend on extra-financial characteristics of green and social bonds and could also drive their expectations. In this case, preferences represent the willingness of investors to foster prominent sustainability factors by investing in financial instruments with specific ESG attributes.

In the case of green and social bonds, the question is now to distinguish between green and social investors' preferences. Since the sign of the two premia goes in the opposite direction, their preferences should not be alike. First, we estimate panel regression models in which we confront several financial and extra-financial characteristics. As we previously unveiled, the bond premia can be substantially different between markets, given the currency segmentation. Therefore, we split the analysis by considering sub-samples based on the currency denomination.

4.1 A model of premium factors

To be comparable, the analysis is conducted symmetrically on green and social bond premia. First, we might consider that the spread depends linearly on the bond's intrinsic features, commonly accepted in the academic literature. We integrate the modified duration, the issuance size and the bond liquidity level[15]. We also have to control for the effect of issuer and seniority biases. To attest the green and social preferences of investors, we introduce several quantitative and qualitative extra-financial variables. One aspect judged as critical in the green bond market is certification. In the sustainable bond market, certification appears as the decisive criterion to consider the underlying project as green/social. This is an issue of credibility (Kapraun *et al.*, 2021). Issuers with a CBI certification are sending a positive signal to investors, and dissociating from greenwashing (Flammer, 2021). To another extent, an external review that acts as a third party verification can also be considered as a positive signal. We assume that such criteria are rewarding processes for bond issuers since the time and the cost they imply might also send a positive signal to the market. In the same vein, we also deem the post-issuance of an allocation and an impact report to be a distinctive factor in the sustainable bond market. The allocation report provides the amount allocated to projects while the impact report quantifies the environmental or social impact of the project. Finally, as most of the targeted social and green objectives are related to sustainable development goals and ESG milestones, we can expect that the number of targets either SDGs or ESGs impacts the trustworthiness of the project.

[15] Credit ratings could not be included in the model due to multi-collinearity issues.

To test for the effects of all variables unlighted previously, we specify the following econometric regression model:

$$\begin{aligned}\boldsymbol{\mathcal{P}}_i(t) = & \underbrace{\beta_{\text{MD}}\,\text{MD}_i(t) + \beta_{\mathcal{L}iq}\ln\left(\mathcal{L}iquidity_i(t)\right) + \beta_{\mathcal{S}ize}\ln\left(\mathcal{S}ise_i(t)\right) + \beta_{\mathcal{D}om}\mathcal{D}omestic_i}_{\text{Financial characteristics}} + \\ & \underbrace{\sum_{j=1}^{3}\beta_{\mathcal{S}eniority,j}\mathcal{S}eniority_{i,j}(t)}_{\text{Seniority}} + \underbrace{\sum_{j=1}^{3}\beta_{\mathcal{S}ector,j}\mathcal{S}ector_{i,j}(t)}_{\text{Sector}} + \\ & \underbrace{\beta_{\text{SDG}}\,\text{SDG}_i + \beta_{\text{ESG}}\,\text{ESG}_i + \beta_{\text{AR}}\text{AR}_i(t) + \beta_{\text{IR}}\,\text{IR}_i(t)}_{\text{Use of proceeds}} + \\ & \underbrace{\beta_{\text{CBI}}\,\text{CBI}_i + \beta_{\text{External}}\,\text{External}_i}_{\text{Credibility}} + \varepsilon_i(t)\end{aligned}$$

where $\boldsymbol{\mathcal{P}}_i(t)$ is the green/social bond premium of security i at time t. The set of explanatory variables can be split into five families: financial or bond characteristics, seniority, sector, use of proceeds and credibility. $\text{MD}_i(t)$, $\mathcal{L}iquidity_i(t)$ and $\mathcal{S}ise_i(t)$ are respectively the modified duration, the liquidity score[16] and the size/notional of the bond i at time t. The dummy variables $\mathcal{D}omestic_i$ takes the value 1 if bond i is denominated in local currency. $\mathcal{S}eniority_{i,j}(t)$ and $\mathcal{S}ector_{i,j}(t)$ are other dummy variables. They indicate whether the bond is senior, non-preferred senior or subordinated. For the sector, we make the distinction between corporates, financials and supranational bonds. We omit the covered and agency/sovereign categories to avoid multi-collinearity issues. Thus, the beta associated with either one specific seniority (or sector) represents the excess premium with respect to covered (or agency/sovereign) bonds. The following extra-financial data are retrieved from Bloomberg. SDG_i and ESG_i sum the number of SDGs and ESG themes targeted by the project[17]. $\text{AR}_i(t)$ is a dummy variable which is equal to 1 in the case of the availability of an allocation post-issuance report. The variable $\text{IR}_i(t)$ is analogous to the allocation report with the impact report. Finally, two dummy variables are included to assess the credibility of the green/social project. While CBI_i is equal to 1 when the bond is certified by CBI, External_i is equal to 1 when the bond's project has been reviewed by an external auditor. The panel regression model includes time-fixed effects and take into account the presence of heteroskedasticity and serial correlation by using a robust standard error estimator (Newey and West, 1987). Furthermore, at each step of the regression, we control for multi-collinearity issues with the variance inflation factor (VIF).

4.2 The determinants of the greenium

In Table 7, we report the panel regression results for green bonds with respect to the currency segmentation[18]. First of all, we notice relatively low values for the coefficient of determination $\mathfrak{R}_c^2$ ranging between 3% and 7%, which emphasizes the weak capacity of our model to make accurate predictions. We ensure that the max value of the VIF cannot be greater than 6. The F-test confirms the rejection of the null hypothesis which stipulates that the beta coefficients are not different from zero. We also report the number of observations and bonds within each sample.

Considering the financial characteristics, we observe that the modified duration demonstrates a negative relationship with the green bond premium. This coefficient is statistically

[16] The liquidity is estimated with the bid-ask spread.
[17] This number can range between 0 and 14 for the SDGs and between 0 and 13 for the ESG themes.
[18] We remind that AC stands for all currencies and corresponds to the global analysis.

Table 7: Panel regression estimates for the green bond premium

	AC	EUR	USD	Non-EUR
Bond characteristics				
Modified duration	−0.011	−0.144***	−0.036	−0.143***
	(0.023)	(0.035)	(0.079)	(0.042)
Liquidity	−3.281***	−1.696***	−8.369***	−0.633**
	(0.286)	(0.460)	(0.715)	(0.322)
Size	0.281	−0.548*	−1.778*	1.551***
	(0.191)	(0.328)	(1.034)	(0.251)
Domestic	−0.056	−1.059***	−1.182**	−0.603**
	(0.171)	(0.252)	(0.509)	(0.279)
Seniority				
Senior	−0.088	−1.015***	−0.822	−3.309***
	(0.249)	(0.291)	(0.517)	(0.516)
Non-preferred senior	−1.301***	−0.828*	−14.294***	
	(0.398)	(0.437)	(1.247)	
Subordinated	−1.918	−3.563		
	(2.815)	(2.767)		
Sector				
Corporates	−1.687***	−3.905***	2.460***	1.892***
	(0.215)	(0.268)	(0.672)	(0.442)
Financials	1.365***	−0.737**	4.785***	1.114**
	(0.255)	(0.315)	(0.742)	(0.433)
Supranational	−0.784***	−0.587***	−3.151***	0.632**
	(0.167)	(0.210)	(0.452)	(0.293)
Use of proceeds				
SDG	−0.296***	−0.258***	−0.796***	−0.116***
	(0.025)	(0.037)	(0.092)	(0.031)
ESG	0.317***	0.355***	0.204***	0.306***
	(0.029)	(0.047)	(0.070)	(0.041)
Allocation report	0.164	−0.209	2.136***	0.528*
	(0.214)	(0.297)	(0.513)	(0.314)
Impact report	−0.670***	−2.754***	0.102	0.479
	(0.259)	(0.408)	(0.474)	(0.375)
Credibility				
CBI certification	−2.138***	−3.747***	−3.500***	0.614
	(0.525)	(0.784)	(0.714)	(0.961)
External review	−1.190***	−1.063**	−0.300	−7.241***
	(0.328)	(0.492)	(0.515)	(0.692)
Statistics				
$\mathfrak{R}_c^2$	0.032	0.050	0.058	0.077
VIF (max)	3.670	4.200	5.970	4.450
F-test	118.800***	103.900***	67.200***	54.990***
# Observations	56 850	31 666	15 943	9 241
# Bonds	659	352	199	108

significant at the 99% confidence level only for EUR- and non-EUR-denominated bonds. As generally accepted, green bonds with shorter durations tend to have higher excess yields. The effect of liquidity on the greenium is also negative and statistically significant. We notice that this financial indicator is the only one to be statistically significant at the global level and across all sub-samples. With regard to the issuance size, the relationship tends to be positive and statistically significant for non-EUR-denominated bonds. Kapraun *et al.* (2021) suggested that the size of issuance is relevant for investors only if the related project has a confirmed environmental impact. Consequently, large green bonds with accepted projects tend to trade at lower yields than smaller green bonds. When we consider the domestic dummy variable, we notice that bonds denominated in local currency have a lower premium of approximately -1 basis point than bonds denominated in foreign currencies. Therefore, investors tend to reward the issuance of green bonds denominated in local currencies, which reduces exchange risk (Nanayakkara and Colombage, 2019).

Concerning the seniority of debt, we observe that senior bonds exhibit a lower premium compared to covered bonds, although the effect is only proven for EUR- and non-EUR-denominated bonds. The effect is even more pronounced for non-preferred senior bonds, notably for USD-denominated bonds with a premium of -14.3 bps lower than covered bonds. Since this category of seniority is available to banking institutions, this result sheds light on the premium effect for the specific pool of banking institutions in the sample. The coefficients are not statistically significant for subordinated bonds, although recording an even lower premium globally and for EUR-denominated bonds. Regarding sector segmentation, we notice that compared to AS issuers, supranational issuers have a lower premium regardless of the currency effect. For financial issuers, the premium tends to be greater than the premium of AS issuers, except for EUR-denominated bonds. Finally, corporate issuers tend to have a lower premium, notably when the issuance is made in euros. However, the relationship becomes positive when the issuance is made in other currencies, especially in dollars. These results shed light on a clear cutoff between sectors, as the premium reduction is greater for EUR-denominated corporate green bonds, while the premium tends to increase for non-EUR-denominated issuers.

Turning to the extra-financial dimension, we observe an attractive effect of the use of proceeds specification for green projects. As the number of SDG targets increases, the green bond premium tends to decrease. This effect is slight but verified and statistically significant across samples. On average, by targeting one additional SDG, the green premium tends to decrease by -0.3 bps. Conversely, the relationship between the number of ESG-related themes and the greenium is positive, suggesting that as the number of ESG targets increases, the green bond premium tends to increase. Again, the impact is relatively weak, but it is also verified and statistically significant in each sub-sample. While one might expect that the two variables are closely related, the results suggest that they are strongly different and even opposite. Investors with green preferences tend to favor the credibility of the green project with multiple SDGs, while the surge in the number of ESG themes tends to discredit the green project. One possible explanation is that green investors prefer the reliable framework of the SDGs, which is accompanied by KPIs, rather than disparate and heterogeneous ESG themes, which can divert investor preferences. Additionally, investors with green preferences reward the availability of an impact report more than an allocation report. For green bonds denominated in euros, the premium decreases by -2.8 bps when a post-issuance impact report is available. Regarding the certification effect on the green premium, the relationship between the CBI certification and the premium is negative and statistically significant, except for non-EUR-denominated bonds. When considering only extra-financial indicators, the betas for certification tend to be the highest. In the green bond market, obtaining CBI certification lowers the risk of greenwashing, increasing investor

demand, which in turn lowers the premium. Similarly, certification from an external reviewer is also rewarded by investors, notably for non-EUR-denominated bonds. Therefore, green preferences are highly dependent on the green project's characteristics and monitoring.

4.3 The determinants of the social bond premium

In Table 8, we report the regression results for the social bonds. Unsurprisingly, the number of observations on the social bond market is substantially reduced with less than 12 000 observations in the complete sample. The coefficient of determination $\mathfrak{R}_c^2$ ranges in a larger interval, between 6% and 20%. Again, we ensure that the maximum value of the VIF cannot be greater than 6. As a consequence, several factors must be dropped when performing a sub-sample analysis.

Regarding financial characteristics, similar to the case of green bonds, the modified duration tends to have a negative relationship with the social bond premium. The liquidity effect is positive and significant in Europe, but negative for USD- and non-EUR-denominated bonds. In terms of issuance size, the relationship appears to be positive. For the domestic variable, we observe that social bonds denominated in local currencies generally have a slightly lower premium globally. This is also true for EUR-denominated bonds, but not for other sub-samples. Since the social bond market is predominantly driven by European issuers, EUR-denominated bonds tend to have a premium about 2 bps lower than bonds issued in foreign currencies, while for USD-denominated bonds, the premium tends to be 7.7 bps higher. As specified by the seniority segmentation, senior bonds usually have a higher premium, except for green bonds issued in euros. For bonds denominated in currencies other than euros, the effect of seniority is significant and statistically significant at the 99% confidence level. Compared to covered bonds, these bonds have a premium of approximately 5 to 9 bps higher. Unlike the green bond market, sector segmentation is not very conclusive. While financial issuers tend to have a larger premium than AS issuers, no significant effect on supranational issuers has been recorded.

Compared to the green bond market, the critical impact of the use of proceeds on social bond premium is considerably different. Firstly, we notice that for social bonds, the relationship between the premium and the number of SDGs aligned with the project is positive. Unlike green bonds, the more SDGs related to the project, the higher the premium. Despite the slight impact on the premium, investors in the social bond market are less focused on the number of SDG themes. Secondly, when considering the number of ESG themes aligned with the social project, results suggest a negative relationship this time. The effect is pronounced for bonds denominated in dollars, which may indicate the issuer's capacity to have a legitimate social impact. One possible explanation is that ESG themes related to social projects can be more relevant for differentiating between social bonds and, in turn, can be a deciding factor for investors. Again, these results demonstrate that the two variables are substantially different and do not capture the same information about investors' preferences. Similar to the greenium analysis, the availability of an allocation report tends to increase the premium, but only for EUR- and non-EUR-denominated bonds. For the impact report variable, we observe that the relationship tends to be negative. One possible explanation is that the impact report is more scrutinized by investors since the assessment of the project's impact is of prime importance and not systematically provided by issuers, at least for social bonds denominated in euros and other currencies. Regarding certification, the consensus of a negative relationship between certification and premium tends to disappear in the social bond market. Certification tends to substantially increase the social bond premium by 3.5 bps globally and for EUR-denominated bonds as well. One possible explanation is the po-

Table 8: Panel regression estimates for the social premium

	AC	EUR	USD	Non-EUR
Bond characteristics				
Modified duration	-0.212^{***}	-0.325^{***}	0.168	-0.148
	(0.036)	(0.040)	(0.267)	(0.093)
Liquidity	0.031	2.368^{***}	-5.928^{**}	-2.374^{***}
	(0.402)	(0.508)	(2.988)	(0.551)
Size	1.088^{***}	1.583^{***}	30.319^{***}	-0.489
	(0.319)	(0.253)	(4.174)	(0.701)
Domestic	-0.730^{***}	-1.809^{***}	7.783^{***}	2.913^{***}
	(0.276)	(0.368)	(2.048)	(0.737)
Seniority				
Senior	3.417^{***}	-1.797^{**}	-1.785	9.242^{***}
	(0.788)	(0.853)	(2.685)	(2.787)
Non-preferred senior	-0.416	-1.058^{*}	4.119	5.346^{**}
	(0.514)	(0.589)	(4.911)	(2.264)
Sector				
Corporates	1.069^{**}	-0.054		
	(0.428)	(0.625)		
Financials	5.410^{***}	0.518		
	(0.696)	(0.764)		
Supranational	0.031	0.335^{*}		
	(0.212)	(0.194)		
Use of proceeds				
SDG	0.240^{***}	0.305^{***}	0.556^{**}	0.031
	(0.049)	(0.042)	(0.261)	(0.212)
ESG	-0.224^{***}	-0.059	-2.200^{***}	-0.841^{**}
	(0.057)	(0.054)	(0.447)	(0.407)
Allocation report	0.284	0.959^{***}	-2.598	5.355^{***}
	(0.376)	(0.246)	(1.861)	(0.958)
Impact report	0.745^{*}	-1.370^{***}	3.310^{*}	-3.932^{***}
	(0.426)	(0.444)	(1.840)	(0.711)
Credibility				
CBI certification	3.513^{***}	3.549^{***}		-1.139
	(0.439)	(0.887)		(1.452)
External review	-2.732^{***}	-4.005^{***}	3.490^{*}	5.966^{***}
	(0.379)	(1.058)	(1.993)	(0.736)
Statistics				
$\mathfrak{R}^2_c$	0.064	0.071	0.201	0.072
VIF (max)	3.820	5.880	3.040	4.590
F-test	53.640^{***}	46.800^{***}	26.730^{***}	9.500^{***}
# Observations	11 860	9 198	1 187	1 475
# Bonds	156	101	26	29

tential standardization of the certification[19]. As many issuers are certified (over 90% in the AC sample), this may be a less deciding factor when issuing social debt. On the contrary, external review processes tend to negatively and substantially impact the social premium, at least for EUR-denominated bonds. For all issuers, an external certification leads to a reduction of 2.7 bps in the premium. The use of external review appears to be critically important for EUR-denominated bonds. However, the relationship goes in the opposite direction for bonds issued in currencies other than euros.

4.4 Green vs. social factors

In summary, our results show that the market structure of social and green bonds does not rely on similar characteristics. Considering the green bond market, we notice specific effects related to issuer segmentation, which is not the case for the social bond market. Only the size and the modified duration of the bonds are scrutinized by investors and appear as prominent intrinsic characteristics in both markets. In terms of extra-financial features, green bonds tend to have a lower premium when the green project is associated with a high number of dedicated SDGs. Issuers providing impact reports tend to be rewarded, notably for EUR-denominated securities. In line with many other studies, we confirm that certification and external review negatively impact the green premium. In the social bond market, the number of SDGs appears to be less important for investors compared to ESG themes. Contrary to expectations, certified social bonds tend to have a higher premium, although the verification of an external reviewer is critical in reducing the premium. These results shed light on the different factors investors rely on when making their investments.

5 Conclusion

In this study, we compare the green and the social bond market on several grounds. Between 2019 and 2022, the greenium is about -3 bps on average, meaning that, all else being equal, investors are willing to forsake a small share of returns in exchange for environmental benefits. In the EUR-denominated bond market, the greenium has been consistently negative over the years. While the spread between green and conventional bonds denominated in dollars also supports the presence of a greenium (around -4.3 bps on average), we notice a positive spike during the covid-19 crisis in March 2020. Considering market segments, we advocate a higher greenium for supranational issuers, notably in 2019. The trend is similar when we are looking to agencies and sovereign issuers, even if the greenium was not as large in 2019. Moreover, we also notice that these two market segments do not show any major spikes during the market turmoil of 2020 as we observed on the aggregated premia analysis. This could reflect the less volatile nature of the premium for these two categories of issuers. For the social bond premium, we notice fragmented estimates of the premium in the secondary market. In the long run, the premium is close to zero and equal to -0.3 bps on average. The premium becomes slightly positive when bonds are denominated in currencies other than euros. Unlike with green bonds, investors are unwilling to give up returns to support social projects. Therefore, investors do not view environmental and social issues as equally important.

While responsible investors consider that the environmental and social pillars are highly interconnected when implementing ESG strategies, our research shows that the green and social bond markets are clearly not integrated. Indeed, we notice that the social bond premium is not positively correlated with the greenium. On the contrary, we found a negative

[19] No issuers with bonds denominated in dollars are uncertified.

long-term correlation of -53% between the two premia. This result holds when we consider the premia with respect to currency segmentation. Beyond correlation analysis, we investigate the joint dynamics using the Granger causality test. Overall, the estimates suggest that changes in the green bond premium do not help to predict the social bond premium variation.

In the last part of the study, we investigate the factors that determine the premium on both markets through panel regression models. The inclusion of extra-financial information based on the project's use of proceeds and credibility, alongside intrinsic financial variables, enables us to gauge investors' green and social preferences. First, there is a difference between green and social projects when they are financed in euros or in other currencies. Clearly, non-euro projects are subject to a higher premium. Second, we notice that green preferences are sensitive to the macro-impact (number of SDGs aligned) of the project and its credibility (certification and external review). On the contrary, it is more difficult to understand the pricing in the social bond market since many empirical relationships between the social bond premium and extra-financial factors are missing or seem counter intuitive. On one hand, we observe clear distinctive patterns between the two types of preferences. On the other hand, the small size of the social bond market confuses the comparison between sub-samples.

More generally, the level of these two premia (especially the social bond premium) are a long way from reflecting the major concerns about a just transition to a low-carbon economy, and the financing dimension of net zero policies. As the social bond market emerged during the covid-19 crisis, predominantly led by public institutions, we could presume that this market offered another possibility to borrow for these issuers. In this context, we may wonder whether social bonds help to finance (traditional) social debt (unemployment benefits, retirement pensions, etc.) and social infrastructure (schools, hospitals, etc.), or if they really support social projects to achieve a low-carbon economy. Since the social bond premium is equal to zero and the pricing does not depend on extra-financial credibility/certification/reporting, our empirical study shows that they are considered as conventional instruments by investors. We also conclude that the green bond market is more integrated and homogeneous than the social bond market. Therefore, our study highlights the need for greater alignment between the green and social bond markets in order to promote a more comprehensive approach to sustainable finance. The emergence of sustainability bonds in the GSS landscape is certainly one solution, but it questions and challenges the social bond market's position and role.

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A Appendix

A.1 Additional results

A.1.1 Tables

Table 9: Estimated correlation in % between green and social bond premia (4-week moving average)

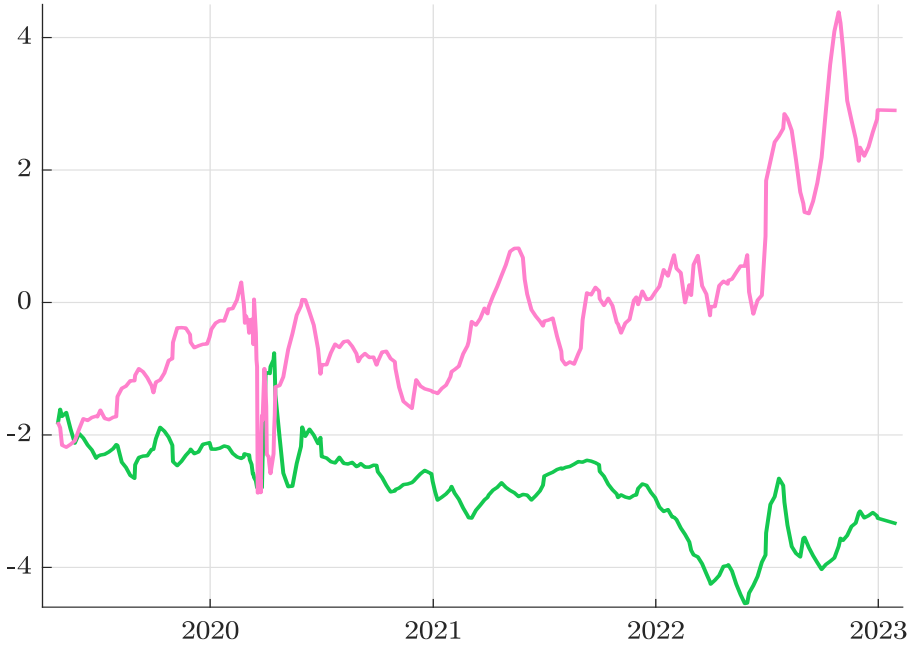
Series	Type	2019	2020	2021	2022	2019–2022
Absolute	Pearson	-48.4^{***}	-10.0	-3.2	40.3^{***}	-62.0^{***}
	Spearman	-47.7^{***}	31.7^{***}	10.7	46.0^{***}	-67.7^{***}
Variation	Pearson	-24.0	-6.8	7.5	21.1	1.9^{**}
	Spearman	-25.2	-11.8	8.0	4.6	-2.5

Table 10: Granger causality test (Social ⇒ Green)

	AC		EUR		Non-EUR		SSA	
Lag	F-test	p-value	F-test	p-value	F-test	p-value	F-test	p-value
1	0.01	0.88	4.45	0.03^{**}	0.48	0.48	0.00	0.96
2	1.07	0.34	2.12	0.12	0.28	0.74	2.51	0.08^{*}
3	5.94	0.00^{***}	0.41	0.74	0.00	0.99	2.06	0.10
4	4.38	0.00^{***}	0.79	0.52	0.02	0.99	1.93	0.10
5	4.06	0.00^{***}	0.66	0.64	0.01	0.99	1.56	0.17
6	3.30	0.00^{***}	0.53	0.77	0.02	0.99	1.48	0.18
7	2.51	0.01^{**}	0.64	0.72	0.07	0.99	1.21	0.29
8	2.33	0.02^{**}	0.67	0.71	0.07	0.99	1.10	0.36
9	2.31	0.01^{**}	0.59	0.79	0.07	0.99	1.29	0.24
10	2.17	0.02^{**}	0.96	0.47	0.07	0.99	1.22	0.27

A.1.2 Figures

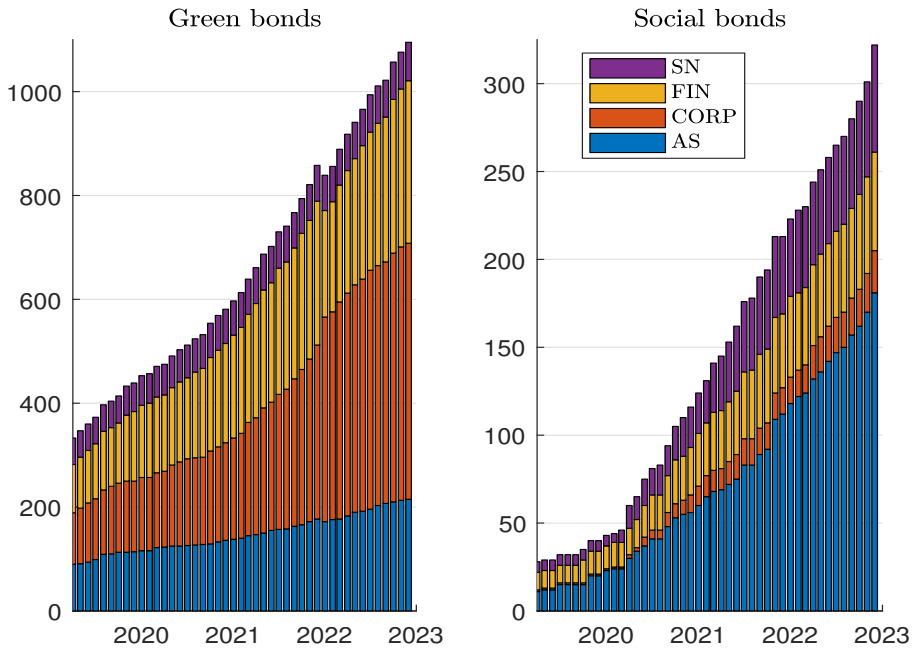
Figure 15: 4-week moving average of the green and social bond premia (in bps)



A.2 Descriptive analysis of the bottom-up data

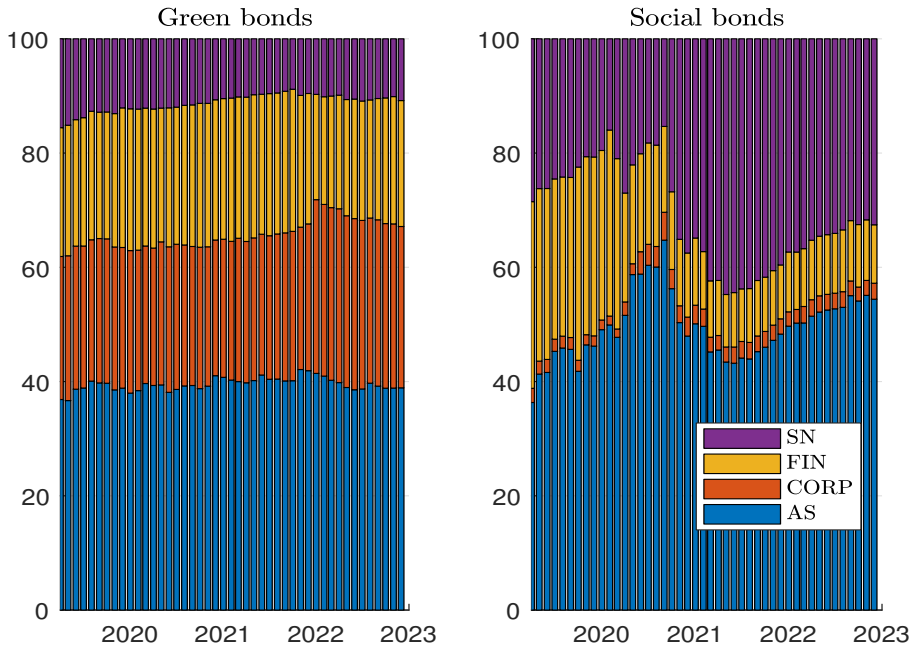
As previously explained, bottom-up data corresponds to the bond constituents of the Bloomberg MSCI Global Green Bond Index and the constituents of the Bloomberg Global Aggregated Index, which are flagged as social bonds. In December 2022, we have 1 095 green bonds and 322 social bonds. The evolution of the bond universe is reported in Figure 16. The sector breakdown shows that the social bond market is dominated by agency, sovereign and supranational issuers since they represent more than 80% of issuance (Figure 17). The green bond market is more balanced (50% for agency, sovereign and supranational issuers and 50% for financial and corporate issuers). Most of bonds are senior or non-preferred senior (Figures 18 and 19). The rating breakdown is relatively stable for green bonds. On average, we have 27% of AAA, 25% of AA, 23% of A and 24% BBB, while non-rated green bonds are less than 2% (Figure 21). For social bonds, the breakdown is very sensitive to the issuance of jumbo bonds by SSA issuers, which are mainly rated AAA and AA. We also observe a greater maturity for green bonds (Figure 23). Finally, the sustainable debt market is dominated by EUR-denominated bonds (Figures 24 and 25).

Figure 16: Sector breakdown of green and social bond benchmarks (# issuers)



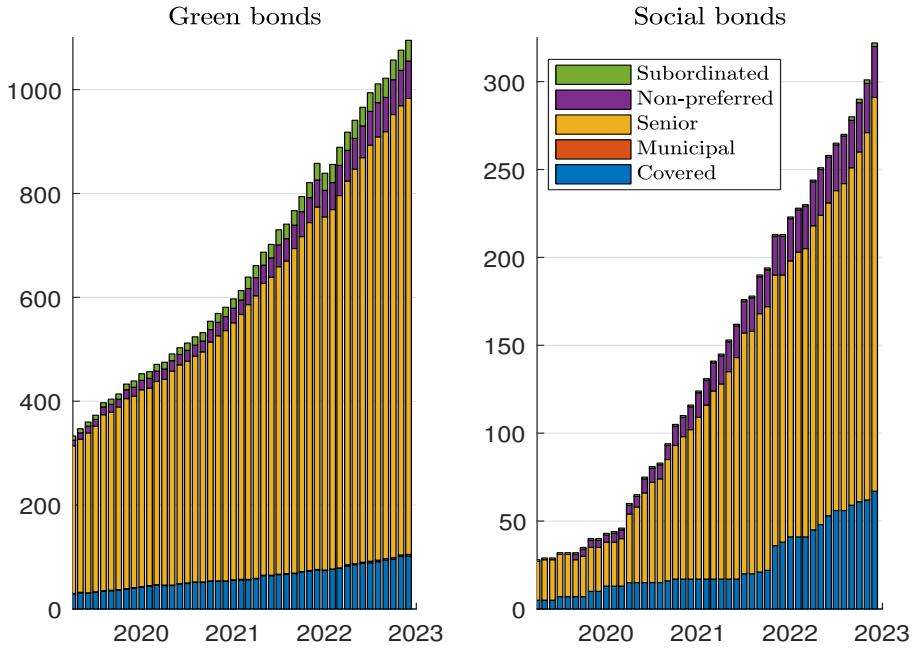
Source: Bloomberg (2023) & Authors' calculations.

Figure 17: Sector breakdown of green and social bond benchmarks (% notional)



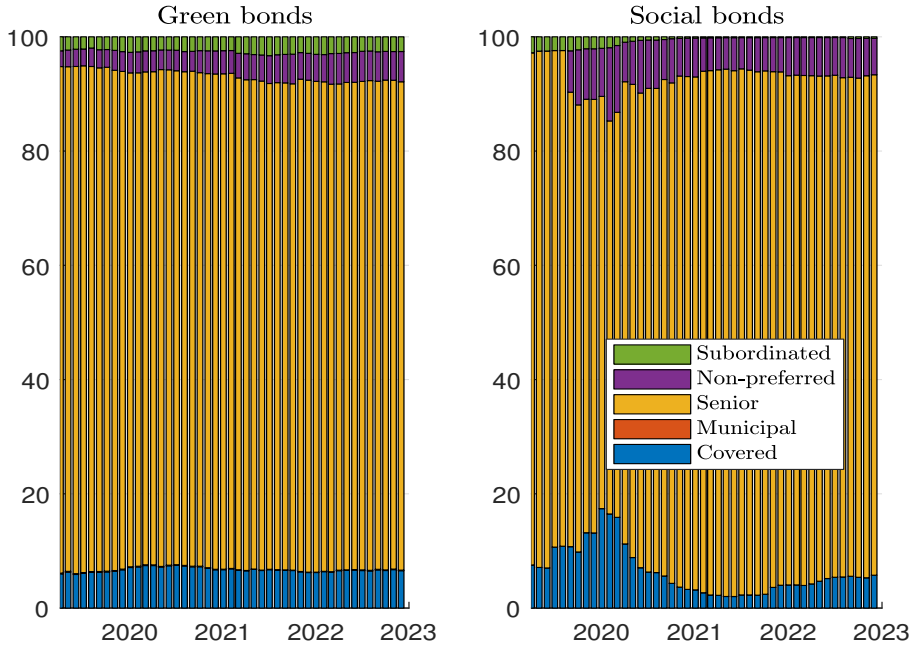
Source: Bloomberg (2023) & Authors' calculations.

Figure 18: Seniority breakdown of green and social bond benchmarks (# issuers)



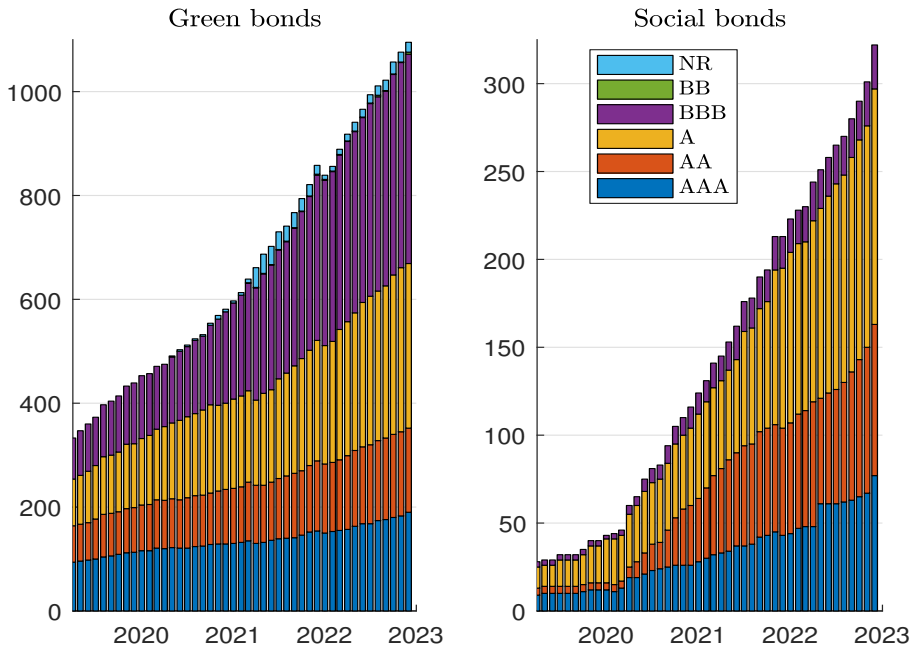
Source: Bloomberg (2023) & Authors' calculations.

Figure 19: Seniority breakdown of green and social bond benchmarks (% notional)



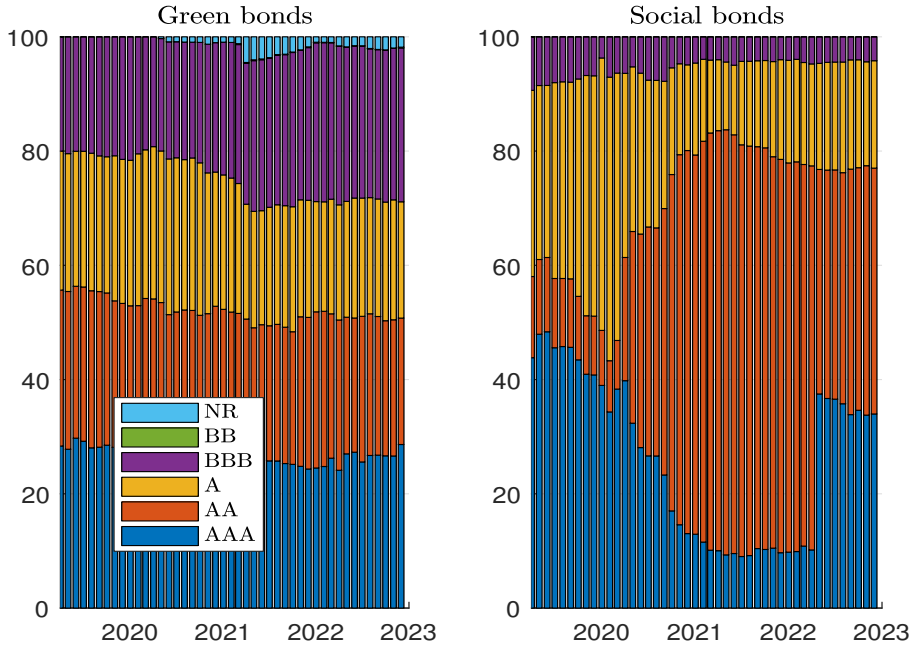
Source: Bloomberg (2023) & Authors' calculations.

Figure 20: Rating breakdown of green and social bond benchmarks (# issuers)



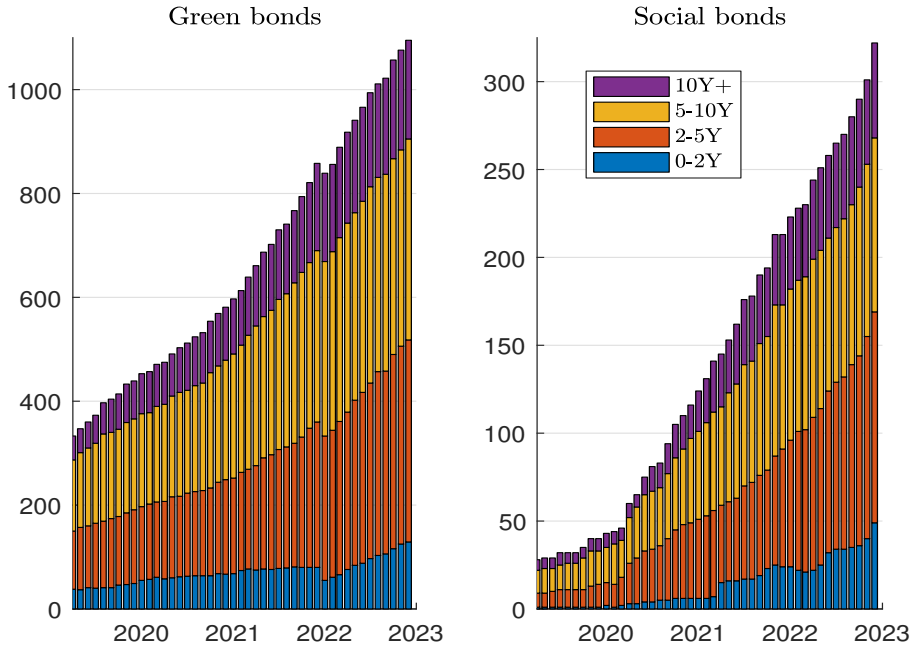
Source: Bloomberg (2023) & Authors' calculations.

Figure 21: Rating breakdown of green and social bond benchmarks (% notional)



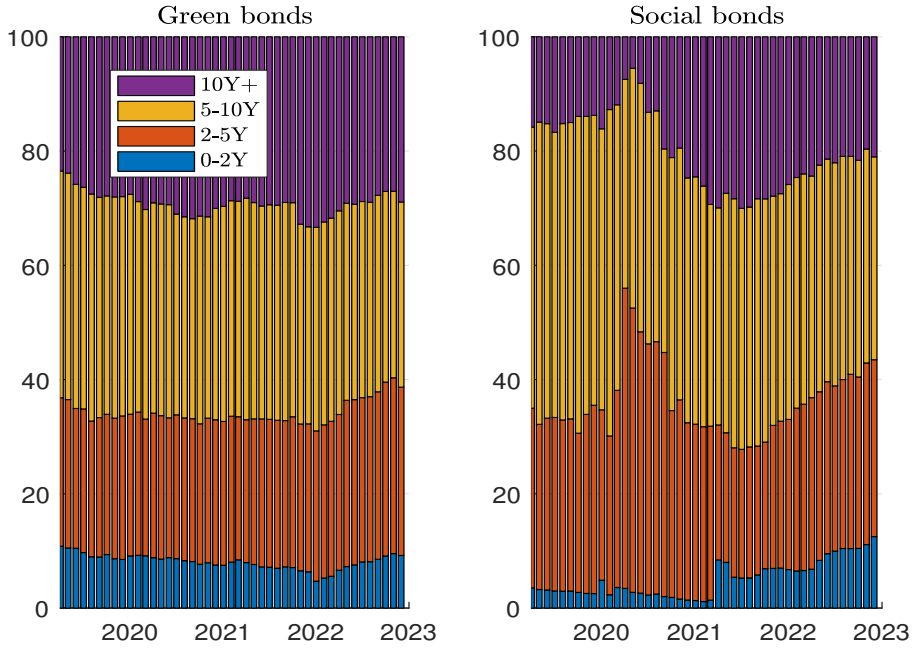
Source: Bloomberg (2023) & Authors' calculations.

Figure 22: Maturity breakdown of green and social bond benchmarks (# issuers)



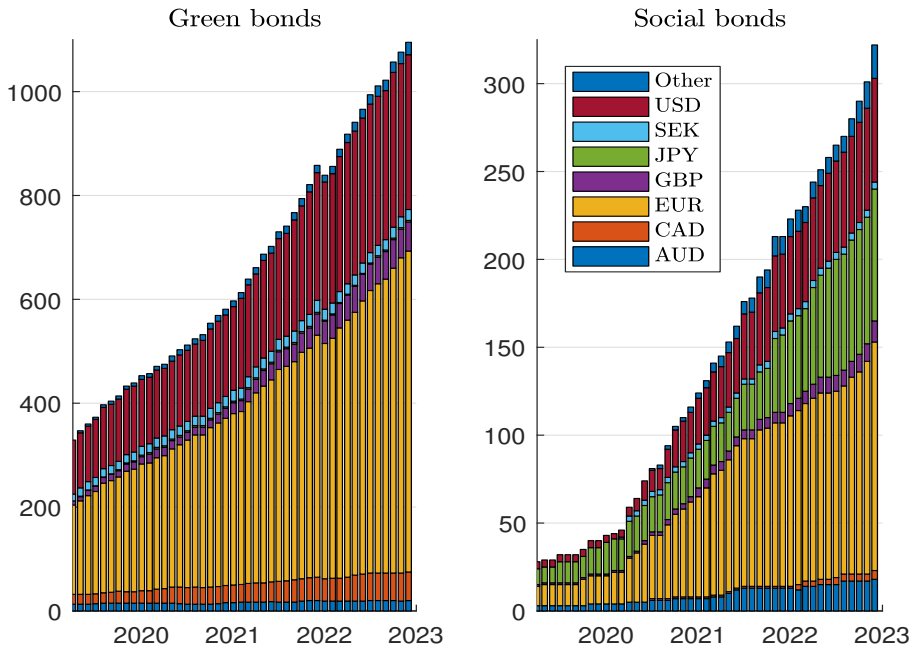
Source: Bloomberg (2023) & Authors' calculations.

Figure 23: Maturity breakdown of green and social bond benchmarks (% notional)



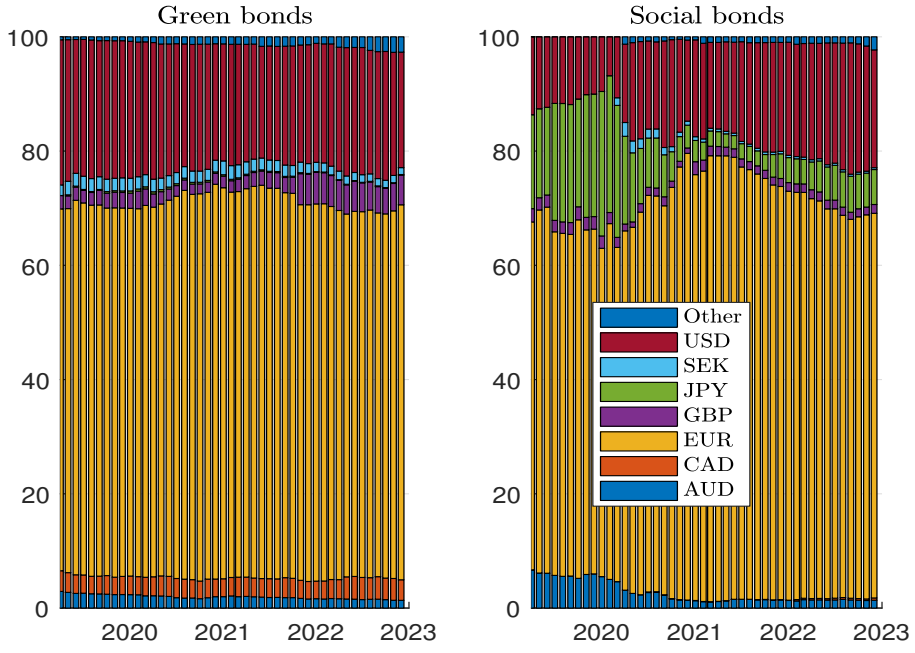
Source: Bloomberg (2023) & Authors' calculations.

Figure 24: Currency breakdown of green and social bond benchmarks (# issuers)



Source: Bloomberg (2023) & Authors' calculations.

Figure 25: Currency breakdown of green and social bond benchmarks (% notional)



Source: Bloomberg (2023) & Authors' calculations.