Sustainable debt market and the search of premium in bonds

Beatrice Boumda [a], Cristina Ortiz [b,*], Carlos Serrano [c], and Luis Vicente [d]

[a] Department of Accounting and Finance, Universidad de Zaragoza. Facultad de Economía y Empresa. C/Gran Vía 2, 50005 Zaragoza (Spain). Email: bboumda@unizar.es

[b] IEDIS. Department of Accounting and Finance, Universidad de Zaragoza. Facultad de Economía y Empresa. C/Gran Vía 2, 50005 Zaragoza (Spain). Email: cortiz@unizar.es

[c] IEDIS. Department of Accounting and Finance, Universidad de Zaragoza. Facultad de Economía y Empresa. C/Gran Vía 2, 50005 Zaragoza (Spain). Email: serrano@unizar.es

[d] IEDIS. Department of Accounting and Finance, Universidad de Zaragoza. Facultad de Economía y Empresa. C/Gran Vía 2, 50005 Zaragoza (Spain). Email: lavicent@unizar.es

[*] Corresponding Author

Acknowledgements: with the support of the European Cost Acton: COST CA19130, and Cátedra Ibercaja Finanzas Sostenibles.

Sustainable debt market and the search of premium in bonds

The paper offers a retrospective of the sustainable debt market, encompassing well-known green bonds that finance environmentally friendly projects and other bonds aimed at funding social or sustainable initiatives. We investigate whether issuers can obtain premiums on sustainable bonds, considering investor perceptions of sustainability and risk. With comprehensive temporal and geographical data, we compare the presence of varying yields at issue based on various bond or issuer characteristics. Despite prior debates in the literature, our results do not reveal any premium.

Keywords: GSS+ bonds, green bonds, premium

1. Introduction

There is a relatively recent and notable trend among companies and institutions to finance projects through sustainable bonds, driven by a growing global concern for environmental, climate, and social responsibility. While green bonds have received major attention and have been the subject of prior analysis within the existing literature, this research aims to broaden the scope by incorporating various other categories such as social and sustainable bonds. Green bonds are exclusively focused on environmentally friendly projects, while sustainable bonds have a broader mandate that includes social as well as environmental objectives.

The Paris Agreement establishes a landmark on climate change (keep the global temperature rise under 1.5-2ºC) compared to pre-industrial levels. Consequently, some movement emerges with the goal of a zero-emission economy by 2050 (Bouckaert et al., 2021)

The first green bond was issued in 2007 by the multilateral institutions European Investment Bank (EIB) and World Bank. That bond was issued with a AAA rating. During the subsequent years, the issuances were scarce in numbers and in amount and limited to agencies, supranational entities, and development banks. However, the surge in the market began around 2013 and 2014. Corporations, as well as municipalities, started to issue green bonds in 2013 (Massachusetts in June 2013). The take-off was also backed up by the publication of Green Bond Principles (GBP) in 2014 by the International Capital Market Association, which are regularly updated till date (ICMA, 2022a). The GBP are designed to promote transparency and integrity in order to increase capital allocation to environmentally friendly projects. The GBP are guidelines generally accepted by the market. Specifically, they provide issuers with the elements to be defined as Green Bond, they serve as an external evaluation of the issuance to gain credibility and transparency to investors, and to policymakers they are guidelines.

The first bond that pursued social objectives was issued in November 2006 by the International Finance Facility for Immunisation to complement funding from European governments to get funds for health and immunization in poor countries. A social bond raises funds to finance projects with positive social outcomes. The publication of the Social Bond Principles (SBP) in 2016 by ICMA (ICMA, 2022b) was the onset of the use of this tool. Supranational issuances filled the market at the foundations which expanded later to government agencies, and financial and corporate issuers. For instance, the Spanish development agency ICO issued 1 billion euros in social bonds to finance SMEs in less favored regions of Spain. The social bonds are now classified into four groups, i.e., standard social use of proceeds bond, social revenue bond, social project bond, and secure social bond. The Covid-19 pandemic also stressed the need for funds directed at health recovery.

Further, the dimension of these issuances broadened and ICMA published the Sustainable Bonds Guidelines (SBG) (ICMA, 2021). A sustainable bond is defined as any type of bond instrument applied to finance or re-finance a combination of both Green and Social Projects. This classification is determined by the issuer based on their primary objectives for the underlying projects. In 2012, Air Liquide became the pioneer of sustainable bonds by issuing its first offering, raising 500 million euros to fund the acquisitions of Gasmendi and LVL Médical, two major firms in the home healthcare sector in Europe. This bond was granted Socially Responsible Investment (SRI) status, with Vigeo, an extra-financial rating agency, conducting a comprehensive analysis of Air Liquide's business operations under social, environmental, and governance criteria. The deal was a great success with interest coverage 6.6 times the nominal amount.[1]

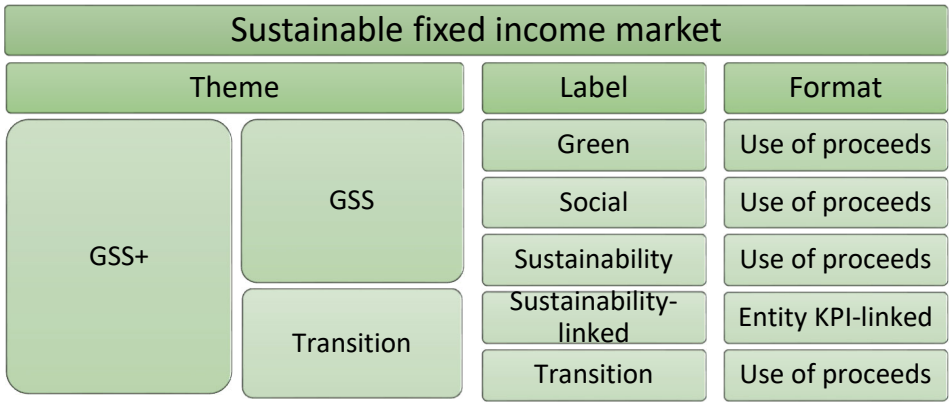
The issuers of Green, Social, and Sustainability Bonds (GSS) should provide the four core components to be aligned with the GBP, which are: Use of Proceeds, Process for Project Evaluation and Selection, Management of Proceeds, and Reporting. All of the documentation together is recommended to be plasma in a Green Bond Framework and accompanied if it is the case, with External Reviews.

A recent type of issuance to include in the sustainable debt market classification is the Sustainability-Linked Bonds (SLB). SLB are any type of bond instrument Issuers are committing explicitly to future improvements in sustainability outcomes within a predefined timeline. This is an instrument for general purposes, therefore the use of proceeds is not a key element to classify the product, the objectives are measured through predefined Key Performance Indicators (KPIs) and assessed against predefined Sustainability Performance Targets (SPTs), as defined in the Sustainability-Linked Bond Principles (ICMA, 2020). The issuers employ this format to define and signal to investors their transition pathways.

[1] "Socially responsible investment unsecured fixed rate notes – Air Liquide" in Société Générale Actus & Opinions website, October 12, 2012. https://wholesale.banking.societegenerale.com/fr/actus-opinions/toutes-publications/news-details/news/socially-responsible-investment-unsecured-fixed-rate-notes-air-liquide/

Figure 1 synthesizes the classification of the sustainable debt market.

Figure 1: Sustainable debt market



We observe the development of the sustainable bond market in comparison to the global debt market. According to data from the Bank for International Settlements, the worldwide outstanding debt reached an estimated $141.04T as of December 2022. This substantial debt is divided according to the issuer, with general government debt accounting for 50%, corporate debt for 48.41%, and other international organizations for 1.52% of the total outstanding debt. According to the Statista Research Department, the outstanding value of sustainable debt instruments amounted to approximately $5.1T.

From a corporate perspective, there is a great interest in these sustainable bonds due to society's increasing valuation of companies' environmental commitments. This perspective is supported by Flammer (2021) as part of a signaling argument. However, the literature also examines the phenomenon of greenwashing, traditionally understood as a practice in which companies inaccurately represent or exaggerate their environmental commitments by selectively disclosing information or presenting deceptive narratives (Lyon and Maxwell, 2011; Shi et al., 2023).

In addition to the disclosed green bond framework provided by issuers, companies have the option to seek external review of the use of proceeds to ensure alignment with the issuance's objectives under the well-known Climate Bond Standard & Certification Scheme developed by Climate Bonds Initiative (CBI, 2019). Independent firms offer services such as 'Third Party Assurance' (e.g. KPMG, Deloitte), 'Second Party Opinion' (e.g. Sustainalytics, Vigeo Eiris, Oekom), or 'Green Bond rating' (e.g. Moodys and S&P). This verification process enhances the issuer's credibility and makes the bond more appealing to investors and other market participants. Regulators worldwide are trying to reform the ESG labeling market to ensure labels are more accurate and do not mislead investors.

Another crucial consideration in sustainable debt issuance for companies is the cost of capital. Initial hypotheses suggest that green bond issuers would benefit from a lower yield than conventional bonds because investors are willing to sacrifice a portion of their returns to align with their sustainable ideals. On one hand, investors demonstrate a significant appetite for sustainable investments. According to a report from Boring

Money[2] in the UK, 27% of investors state they hold a sustainable investment, and half of all fund investors plan to increase sustainable holdings over the next 12 months (with 10% planning to increase 'a lot'). However, the cost of verification and certification of sustainable issues can generate administrative and compliance costs, which counterbalance the equation.

The majority of previous literature addresses the analysis of the bond premium from a global perspective or focused on a single country, primarily the USA or Chinese markets in recent studies (Wang et al., 2020). However, they do not explore the phenomenon on a regional or country-specific basis.

Our findings indicate that there is no premium in the issuance of green bonds compared to their conventional counterparts and the results are consistent across various factors including seniority, domicile, industrial sector, and certification status of green bonds.

Our contribution to the literature is threefold. First, this study on the premium of sustainable bonds compared to their conventional counterparts strengthens the debate on the cost of debt. Secondly, we contribute to the literature on the sustainable debt market by broadening the scope beyond the predominant focus on green bonds evident in prior research. Finally, we contribute to the literature by providing a comprehensive landscape of the global sustainable market. While previous studies often concentrate on individual countries, our comparative study fills a crucial gap. Numerous robustness tests are conducted across various factors, including type of debt, country, and bond verification status, among others.

This paper is organized as follows. The second section conducts an exploration of the key figures and historical milestones of the sustainable debt market. The third section presents the literature review. Our empirical approach is detailed in the fourth section, followed by the presentation of results in the fifth section. A final section concludes.

2. Evolution of the sustainable debt market in figures

We compile the database from Eikon Refinitiv, extracting all bonds labeled with the ESGbond flag issued between December 31, 2009, and December 31, 2023. This results in a total of 14,793 GSS+ bonds.

Table 1 presents the distribution of the number of bonds and the total amount issued across years. The total annual amount in the sustainable debt market reached a peak in 2021, but there was a drop of nearly 20% in 2022, followed by an additional 10% decrease in 2023. Factors such as rising interest rates and high volatility may have contributed to the decrease in bond issuance. Green bonds dominate the sustainable market, accounting for 59.2% of the cumulative volume issued.

[2] Sustainable Investing Report, 2022. Boring Money.

As shown in Table 2, supranational issuers played a pivotal role in inaugurating the sustainable debt market, but the focus and the majority of the market now lie on corporate bonds. Our paper specifically centers on corporate sustainable GSS+ bonds.

In our dataset, we track the evolution of the sustainable debt market. In 2023, the sustainable debt market issued a total of $909.71 billion, distributed as follows: 33.29% from general government, 57.05% from corporate bonds, and 9.66% attributed to other international organizations. Reflecting on the past decade, in 2013, the total amount of sustainable debt issued was $4.7 billion. During this period, the distribution was 17.44% from general government, 24.85% from corporate bonds, and 57.71% classified as supranational debt. This data underscores a substantial growth of the sustainable debt market and a shift away from supranational debt towards corporate debt over the past ten years.

Table 1: Sustainable debt market by type of investment objective (GSS+ bonds)

This table reports the number of bonds issued and the total issuance amount (in billion USD) per year. Bonds are categorized as green, social, sustainable, sustainability-linked (SLB), and transition bonds based on the Refinitive flag.

	Green		Social		Sustainable		SLB		Transition		Total	
Year	# of bonds	Amount (bn USD)	# of bonds	Amount (bn USD)	# of bonds	Amount (bn USD)	# of bonds	Amount (bn USD)	# of bonds	Amount (bn USD)	# of bonds	Amount (bn USD)
2010	53	2.66	1	0.27	0		0		0		54	2.93
2011	29	0.77	1	0.08	0		0		0		30	0.85
2012	24	2.44	5	2.30	0		0		0		29	4.74
2013	45	12.63	3	0.76	1	0.55	0		0		49	13.94
2014	139	30.77	3	1.05	2	0.65	0		0		144	32.47
2015	304	47.67	11	3.47	4	1.50	0		0		319	52.64
2016	255	98.23	10	2.88	18	5.62	0		0		283	106.73
2017	455	162.57	45	11.17	68	15.87	0		1	0.50	569	190.11
2018	547	159.79	55	14.22	136	40.13	0		0		738	214.15
2019	950	284.39	85	18.46	215	83.43	5	5.74	4	1.77	1,259	393.78
2020	1,197	290.27	265	180.25	283	176.39	20	9.62	9	3.16	1,774	659.70
2021	2,064	655.99	554	226.44	615	232.42	276	130.37	14	5.34	3,523	1250.56
2022	1,752	576.06	567	154.10	593	175.49	212	90.93	55	6.83	3,179	1003.41
2023	1,684	538.28	516	146.65	448	160.85	179	62.48	16	1.44	2,843	909.71
Total	9,498	2,862.53	2121	762.10	2383	892.89	692	299.14	99	19.04	14,793	4,835.71

Table 2: Sustainable debt market by type of issuer

This table reports the number of bonds issued categorized by the type of issuer, including corporate, sovereign, and supranational. The amount weight indicates the amount issued by the type of issuer over the total amount in a given year.

	Corporate		Sovereign		Supranational	
Year	# of bonds	Amount weight	# of bonds	Amount weight	# of bonds	Amount weight
2010	-		5	3.56%	49	96.44%
2011	-		3	1.86%	27	98.14%
2012	5	53.91%	4	13.91%	20	32.18%
2013	18	24.85%	8	17.44%	23	57.71%
2014	79	43.82%	23	23.49%	42	32.69%
2015	213	55.49%	35	30.29%	71	14.22%
2016	173	61.58%	54	21.98%	56	16.44%
2017	371	49.01%	104	41.19%	94	9.80%
2018	462	50.98%	97	27.69%	179	21.33%
2019	904	58.73%	178	25.84%	177	15.42%
2020	1,279	44.29%	277	25.56%	218	30.15%
2021	2,737	56.58%	554	29.36%	232	14.06%
2022	2,341	59.17%	614	28.46%	224	12.36%
2023	2,056	57.05%	666	33.29%	121	9.66%
Total	10,638		2,622		1,533	

In total, there are 3,465 unique issuers from 101 different countries in the period from 2010 to 2023. Figure 2 illustrates that in 2023, China emerged as the top issuer of sustainable debt, slightly surpassing 100 billion USD. Alongside France, the USA, Germany, and Japan round out the top five sources of GSS+ bonds in 2023 in terms of the amount issued.

Figure 2: Deals issued in 2023

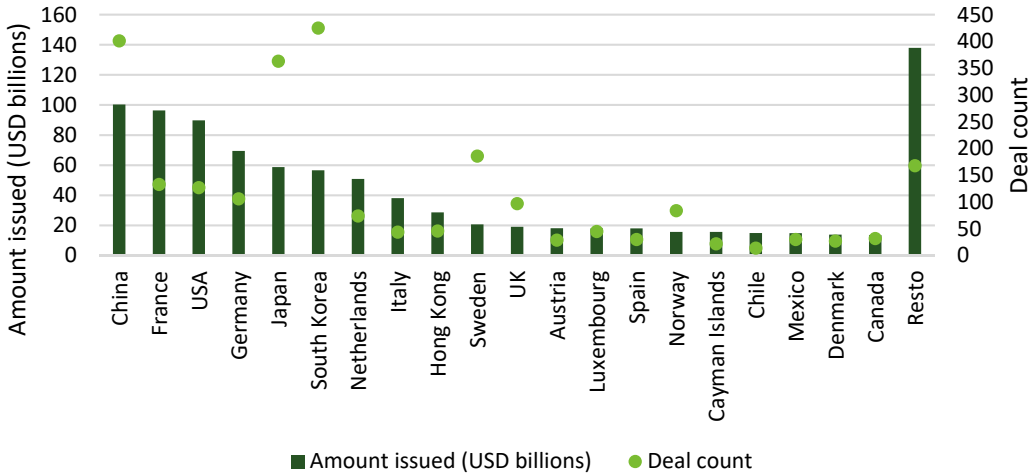
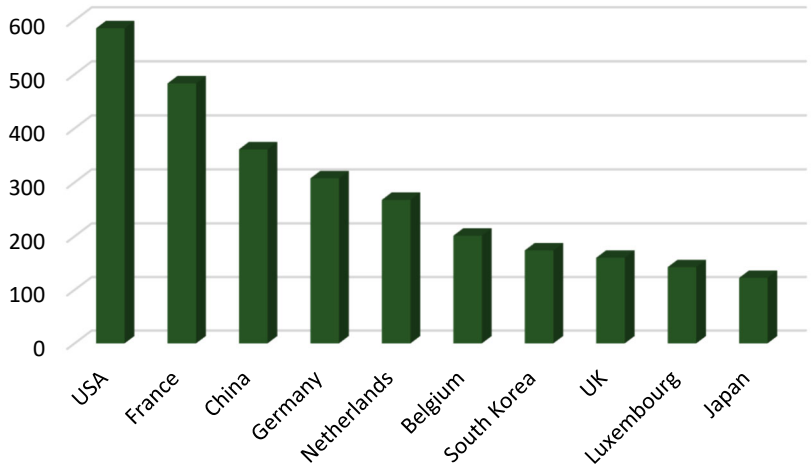


Figure 3 shows the cumulate size of bond issuance from 2010 to 2022, with the USA and France maintaining their leading positions. Notably, smaller countries such as the

Netherlands or Belgium were among the pioneers in embracing this type of product to secure funding for sustainable projects.

Figure 3: Top issuance countries (2010-2022) (in USDbn)



As illustrated in this historical perspective, corporate debt leads the market, with several countries involved in GSS+ issuances. Therefore, our paper focuses on providing a worldwide landscape of the phenomenon.

3. Related literature

The term "greenium," also referred to as the "green bond premium," is a commonly employed expression in literature. This implies that green bonds may be priced at a lower interest rate in contrast to their conventional bond counterparts. While this serves as an incentive for issuers to secure financing at reduced debt costs, it places the decision in the hands of investors, allowing them to determine whether they are willing to forego a portion of their risk-adjusted returns to contribute to the global sustainable effort.

Previous literature has scrutinized the existence (or absence) of this premium in both primary and secondary markets, considering various private or public issuers, concentrating on developed or emerging markets, and employing diverse methodologies. However, consensus regarding the existence of a greenium remains elusive.

Based on the literature review conducted by MacAskill et al. (2021), 56% of primary and 70% of secondary markets studies argue for the existence of a green premium. In the primary market, the issuance of green bonds attracts investors with a green mandate, thereby increasing bond prices and reducing the firm's cost of capital. Ehlers and Packer (2017) identify a green bond premium at issuance within a sample of 21 green bonds, which they find to be greater than the potential costs of a green label or rating. Gianfrate and Peri (2019), who analyzed a comprehensive sample of 121 green bonds issued between 2013 and 2017, note that the issuance of green bonds leads to lower debt costs. This benefit is particularly pronounced for corporate issuers and persists in the secondary market. Similarly, Nanayakkara and Colombage (2019) find that corporate green bonds

exhibit a tighter credit spread of 63 bps compared to similar corporate bond issues using an option-adjusted spread measure. Their analysis involved a sample of 82 green bonds for the period 2016-2017. Zerbib (2019) utilizes a matching method in his analysis of 110 corporate green funds paired with conventional bonds. He observes a small but significant negative premium of approximately 2 bps in the secondary market yields, with a more pronounced effect noted for financial firms and low-rate bonds. Baker et al. (2022) analyzed 3983 green US municipal bonds issued between 2013 and 2018 and controlling for numerous characteristics find that green municipal bonds are priced at a premium.

Conversely, Karpf and Mandel (2018) examined the secondary market yields of 1880 US municipal bonds and discovered a green bond discount. Larcker and Watts (2020), however, contribute to the discourse by shedding light on methodological design misspecifications in prior studies. Through a rigorous matching procedure analyzing 640 green municipal bonds, they conclude that the green premium is essentially zero. Tang and Zhang (2020) do not find a consistently significant premium for green bonds, in an analysis that relates the issuance of green bonds in an international context to the shareholders' benefit of that issuance. Recent research employing stringent matching procedures has found no conclusive evidence of a greenium. Instead, these studies suggest that firms may choose to issue green bonds even at a potential cost, primarily to signal their commitment to sustainability (Larcker and Watts, 2020, Partridge and Medda, 2020 for the municipal US bond market, and Flammer, 2021 for corporate green bonds).

Regarding the matching method, Hachenberg and Schiereck (2018), Bachelet et al. (2019), and Zerbib (2019) use two conventional bonds to build a synthetic, conventional bond by the method of linear interpolation weighted by the conventional bonds' maturities.

The literature also offers different methods for measuring the bond premium. Zerbib (2019) employs ask-yield spread, Flammer (2021) uses the yield at issue, or Nanayakkara and Colombage (2019) who use the option-adjusted spread (OAS).

Some recent papers about the premium in other sustainable products are Torricelli and Pellati (2023) who define the "social premium" analyzing the yield differences in the secondary market of social bonds and conventional bonds, but they only focus in the peak issuing period of one year after the outburst of Covid-19 for a limited sample of 64 social bonds and a naïve matching method. They find a significant positive social premium of 1.242 bps., conventional bonds obtained cheaper financing. Kölbel and Lambillon (2023) for the first sustainability-linked bonds show a premium.

4. Data and methodology

We compile the database from Eikon Refinitiv. We extract all types of corporate non-convertible bonds issued from December 31, 2009, until November 15, 2023, in any of the countries that have issued corporate bonds with the ESGbond flag. This results in a total of 4,484,376 bonds.

Drawing from insights by Flammer (2021) and Pietsch and Salakhova (2022), it is crucial to distinguish climate-related risks, which may exert an unseen influence on the pricing

of sustainable bonds, from other conventional risk metrics linked to the bond issuer. Hence, we limit our sample to bonds issued by issuers with at least one ESG bond. The sample comprises 2,955 issuers with at least one ESG bond, totaling 1,502,699 bonds. For each bond, we collect data from the Eikon Refinitiv database, including the issuer, domicile, amount, currency, issue and maturity date, type of coupon, original yield to maturity, credit rating, seniority, issuer sector, and features such as callable, puttable or perpetual bonds. Descriptive statistics and details of the subsequent cleaning process are provided in Appendix 1.

The goal of the paper is establishing potential causality relationship between the yield of ESG bonds versus conventional bonds purely based on that sustainable characteristic. The original yield to maturity is a continuous outcome variable (Y_i), the treatment variable is D_i., a dummy which takes 1 if the bond is a sustainable bond and 0 otherwise. But the yield of a bond also depends on a series of covariates in the matrix X_i. The initial technique involves model specification, wherein a model is chosen to ascertain causality (see Appendix 2).

$$Y_i = \beta_0 + \beta_1 D_i + \beta X_i + \varepsilon_i \quad (1)$$

However, when it comes to regression adjustments, it becomes challenging to evaluate whether models have accurately specified treatment assignments and covariates to outcomes. Measures of goodness-of-fit, like the coefficient of determination (R2) and mean squared error (MSE), do not verify whether a model is suitable for causal inference. recent research has mostly applied other algorithms such as matching procedures.

4.1. Matching procedure

Rosenbaum and Rubin (1983) propose matching treatment and control observations across multiple dimensions using the probability of treatment conditional on X_i, where X_i is a vector of variables affecting D_i and Y_i. The probability or "propensity score" is defined as the conditional probability of receiving a treatment, given a vector of observed covariates X_i, and it is estimated from a binary choice model as follows:

$$D_i = \beta_0 + \beta X_i + \varepsilon_i \quad (2)$$

Treated (D_i = 1) observations are matched to untreated (D_i = 0) observations with the closest propensity score estimated from Equation (2).

We proceed to match each sustainable bond (treated observations) with the most comparable conventional bond (untreated or controlled observations). The process requires exact matching for the issuer, currency, and seniority. Then, we compute the nearest distance based on a logit regression using the coupon, the log(amountissued), the issue date, and the maturity date. Some restrictions also apply: the maturity of the conventional bond must be two years before or after the sustainable bond, the issue date must be six years before or after the sustainable bond, and the amount issued cannot be 4 times larger or smaller than the sustainable bond. Similar procedures have been used by Zerbib (2019), Wu (2022), or Kölbel and Lambillon (2023).

The final number of sustainable bonds matched with the algorithm that accomplishes all the filters is 2,562 corresponding to 1,233 unique issuers from 52 different countries, issued in 30 different currencies.

Table 3. Descriptive statistics

Descriptive statistics comparing treated and matched bonds in the sample. 2,562 pairs of corporate bonds matched. The sustainable bonds include the GSS+ category. Log(amount issued is the natural logarithm of the issuance amount. Maturity is the maturity of the bond (in years). Coupon is the coupon rate. YTM is the original yield to maturity

	Conventional			Sustainable			Diff	
	Mean	Median	Std.dev	Mean	Median	Std.dev	Mean	p-value
Amount issued (millionsUSD)	259.060	115.08	315.17	251.349	113.216	297.215	-0.021	0.597
Coupon	2.886	2.859	2.280	3.072	3.000	2.152	0.176	0.005
Maturity	5.421	5.003	5.148	5.285	4.996	4.885	1.027	0.340
YTM	3.078	2.950	2.334	3.123	3.005	2.243	0.039	0.541

5. Empirical results

This research stands out as the most comprehensive in its geographical coverage, the number of bonds analyzed, the different types of sustainable bonds considered, and the depth of price history examined, focusing on bonds aligned with the Climate Bond Standards classified as GSS+. Table 4 presents the results of the pairs assigned with the nearest neighbor using a logit to compute the propensity score distance. The findings indicate non-significant yield differences across all bond types, except for sustainability bonds, which exhibit a statistically significant negative difference, representing a premium for companies issuing sustainability bonds. There is a variety of findings in the literature regarding green bonds, but recent studies align in reporting non-significant greenium (Larcker and Watts, 2020; Flammer, 2021). In their analysis of 64 pairs of social bonds for the secondary market, Torricelli and Pellati (2023) report a statistically significant social premium of 1.242 basis points. Conversely, Kölbel and Lambillon (2023) find a non-significant yield difference of -9.1 basis points between SLBs and conventional bonds in a match of 145 pairs.

Table 4: Yields at issue for corporate bonds by ESGType

This table reports the original yield to maturity (YTM) at issue in percentage for GSS+ bonds and the matched nonGSS bonds of the same issuer by the type of sustainable bond. The difference in means is reported jointly along with the corresponding p-value in parentheses.

		GSS+ bonds	Matched nonGSS+ bonds	Difference (p-value)
All bonds	#Bonds ($ Amount billion)	2,562 (259.1)	2,562 (251.3)	
	YTM Mean	3.078	3.123	0.039 (0.541)
Green	#Bonds ($ Amount billion)	1,750 (486.3)	1,750 (501.7)	
	YTM Mean	3.165	3.057	0.108 (0.127)
Social	#Bonds ($ Amount billion)	213 (44.1)	213 (50.4)	
	YTM Mean	3.740	3.541	0.199 (0.726)
Sustainability	#Bonds ($ Amount billion)	400 (76.3)	400 (83.1)	
	YTM Mean	2.958	3.272	-0.314 (0.033)
SLB	#Bonds ($ Amount billion)	167 (68.6)	167 (72.8)	
	YTM Mean	3.321	3.316	0.005 (0.982)
Transition	#Bonds ($ Amount billion)	32 (5.1)	32 (5.3)	
	YTM Mean	1.811	1.826	-0.015 (0.966)

Table 5 displays the results of the differences in yields to maturity among corporate sustainable bonds across various countries. The table reports the top five countries based on the volume of issued sustainable bonds. The results are similar to Flammer (2021) for corporate green bonds in the US, showing a slight negative but statistically insignificant difference between the yields at issue for sustainable and conventional bonds. Wu (2022) reports that yields for 41 Chinese green bonds are 3.4 bps higher than synthetic matched conventional bonds but without any significant information. Similarly, in this paper, we a higher number of matched pairs, we find that yields for GSS+ bonds are higher. Overall, no significant premiums are identified across countries.

Similar results are obtained in Tables 6, 7, and 8 which report the differences in yields by seniority, by industrial sector, and by certification. There are 53 certified bonds in the sample of pairs, all of them are classified as green bonds and certification was provided by Climate Bond Initiative.[3]

[3] The original sample before the matching process included 412 certified bonds, but only one of them was SLB. Two additional agencies reported certifications: PWC and Hong Kong Quality Assurance Agency.

Table 5: Yields at issue for corporate bonds by Domicile

This table reports the original yield to maturity (YTM) at issue in percentage for GSS+ bonds and the matched nonGSS bonds of the same issuer. The difference in means is reported jointly along with the corresponding p-value in parentheses. The table provides information for the top five countries in terms of volume issued in GSS+ bonds.

		GSS+ bond	Matched nonGSS+ bond	Difference (p-value)
China (Mainland)	#Bonds ($ Amount billion)	831 (153.5)	831 (148.9)	
	Mean	4.163	3.999	0.164 (0.043)
United States	#Bonds ($ Amount billion)	129 (76.4)	129 (75.8)	
	Mean	3.957	4.170	-0.213 (0.857)
The Netherlands	#Bonds ($ Amount billion)	84 (60.3)	84 (66.0)	
	Mean	2.857	2.310	0.547 (0.059)
France	#Bonds ($ Amount billion)	112 (56.8)	112 (60.7)	
	Mean	3.476	3.497	-0.021 (0.958)
Germany	#Bonds ($ Amount billion)	199 (49.7)	199(50.7)	
	Mean	1.440	1.471	-0.032 (0.846)

Table 6: Yields at issue for corporate bonds by Seniority

This table reports the original yield to maturity (YTM) at issue in percentage for GSS+ bonds and the matched nonGSS bonds of the same issuer. The difference in means is reported jointly along with the corresponding p-value in parentheses. The table includes the 4 categorizations in seniority labels.

		GSS+ bond	Matched nonGSS+ bond	Difference (p-value)
Secured	#Bonds ($ Amount billion)	191 (66.1)	191 (66.9)	
	Mean	3.620	3.158	0.463 (0.074)
Unsecured	#Bonds ($ Amount billion)	2146 (508.0)	2146 (525.3)	
	Mean	3.296	3.271	0.026 (0.720)
Senior Non-Preferred	#Bonds ($ Amount billion)	121 (36.6)	121 (37.1)	
	Mean	1.074	0.994	0.080 (0.672)
Senior Preferred	#Bonds ($ Amount billion)	104 (40.6)	104 (44.5)	
	Mean	1.805	2.314	-0.510 (0.052)

Table 7: Yields at issue for corporate bonds by Industrial Sector

This table reports the original yield to maturity (YTM) at issue in percentage and 7for GSS+ bonds and the matched nonGSS bonds of the same issuer. The difference in means is reported jointly along with the corresponding p-value in parentheses. According to Refinitiv industry sector classification

		GSS+ bond	Matched nonGSS+ bond	Difference (p-value)
	#Bonds ($ Amount billion)	612 (210.5)	612 (212.5)	
Banks	Mean	2.543	2.498	0.044 (0.724)
	#Bonds ($ Amount billion)	933 (182.6)	933 (199.6)	
Other financial	Mean	3.534	3.467	0.066 (0.626)
	#Bonds ($ Amount billion)	335 (77.6)	335 (79.1)	
Manufactured	Mean	3.119	3.142	-0.023 (0.879)
	#Bonds ($ Amount billion)	244 (74.5)	244 (74.4)	
Electric	Mean	3.252	3.149	0.102 (0.478)
	#Bonds ($ Amount billion)	196 (43.5)	196 (45.1)	
Service	Mean	3.975	3.954	0.022 (0.937)
	#Bonds ($ Amount billion)	137 (25.1)	137 (25.2)	
Transport	Mean	2.648	2.736	-0.087 (0.628)
	#Bonds ($ Amount billion)	34 (14.5)	34 (15.8)	
Consumergoods	Mean	2.312	2.478	-0.166 (0.736)
	#Bonds ($ Amount billion)	33 (12.5)	33 (11.2)	
Energy	Mean	2.384	2.443	-0.059 (0.871)
	#Bonds ($ Amount billion)	12 (3.5)	12 (3.4)	
Gas distribution	Mean	2.317	2.072	0.245 (0.757)
	#Bonds ($ Amount billion)	22 (6.4)	22 (6.7)	
Telephone	Mean	2.608	2.363	0.245 (0.713)
	#Bonds ($ Amount billion)	4 (0.7)	4 (0.7)	
Agency	Mean	1.981	1.861	0.121 (0.787)

Table 8: Yields at issue for corporate bonds by Certification

This table reports the original yield to maturity (YTM) at issue for GSS+ bonds and the matched nonGSS bonds of the same issuer. The difference in means is reported jointly along with the corresponding p-value in parentheses. According to Refinitiv industry sector classification

		GSS+ bond	Matched nonGSS+ bond	Difference (p-value)
	#Bonds ($ Amount billion)	53 (22.3)	53 (25.5)	
Certified	Mean	2.108	2.207	-0.099 (0.753)
	#Bonds ($ Amount billion)	2509 (629.0)	2509 (648.3)	
Non-certified	Mean	3.177	3.136	0.042 (0.548)

Table 9 split the sample by the currency of the issue. The table reveals that bonds denominated in Chinese Yuan present significantly higher yields for conventional compared to sustainable bonds. It is noteworthy that there is a disparity in the number of issues domiciled in China and those denominated in Yuan, with the latter requiring issuing companies to offer higher compensation to sustainable bond investors.

Table 9: Yields at issue for corporate bonds by currency

This table reports the original yield to maturity (YTM) at issue for GSS+ bonds and the matched nonGSS bonds of the same issuer. The difference in means is reported jointly along with the corresponding p-value in parentheses. The table provides information for the top five currencies in terms of volume issued in GSS+ bonds.

		GSS+ bond	Matched nonGSS+ bond	Difference (p-value)
Euro	#Bonds ($ Amount billion)	478 (235.0)	478 (244.3)	
	Mean	2.041	1.848	0.192 (0.119)
US Dollar	#Bonds ($ Amount billion)	381 (187.8)	381 (202.1)	
	Mean	4.046	4.206	-0.160 (0.362)
Chinese Yuan	#Bonds ($ Amount billion)	803 (143.4)	803 (136.3)	
	Mean	3.953	3.772	0.181 (0.004)
South Korean Won	#Bonds ($ Amount billion)	435 (23.1)	435 (22.9)	
	Mean	3.001	3.251	-0.250 (0.015)
Japanese Yen	#Bonds ($ Amount billion)	180 (19.7)	180 (21.5)	
	Mean	0.470	0.425	0.046 (0.170)

5.1. Simultaneous issuances

Another intriguing aspect to explore is the possibility of sustainable bonds being issued simultaneously with conventional bonds. Larcker and Watts (2020) find that in the minority of cases where the issue date coincides, they are initially priced the same. In our sample, only 72 sustainable corporate bonds out of the 2,562 matched pairs are issued simultaneously.

Table 11: Yields at issue for simultaneous issuances

This table reports the original yield to maturity (YTM) at issue for GSS+ bonds and the matched nonGSS bonds of the same issuer. The difference in means is reported jointly along with the corresponding p-value in parentheses.

		GSS+ bond	Matched nonGSS+ bond	Difference (p-value)
Simultaneous	#Bonds ($ Amount billion)	72 (27.5)	72 (27.0)	
	Mean	3.557	3.208	0.350 (0.411)
Non-simultaneous	#Bonds ($ Amount billion)	2490 (623.8)	2490(646.8)	
	Mean	3.144	3.114	0.030 (0.659)

6. Conclusion

This paper provides a comprehensive examination of the premium associated with the issuance of sustainable compared to conventional bonds. While the sustainable debt market has experienced significant growth over the past decade, initial indications suggested that investors were willing to accept lower returns on sustainable bonds in line with their environmental and social ideals. However, our analysis does not find evidence of a premium in sustainable debt at present.

The results remain consistent across various factors including seniority, domicile, industrial sector, and certification status of green bonds. Despite the overall findings, further investigation is warranted into issuances denominated in Yuan. The rapid expansion of the Chinese sustainable debt market may contribute to discrepancies in yields, as sustainable bonds are priced significantly lower than their conventional counterparts.

Further analyses will investigate whether differential original yields are consistent across initial and subsequent sustainable bond issuances by companies. Another intriguing aspect to explore is the possibility of sustainable bonds being issued simultaneously with conventional bonds (Larcker and Watts, 2020).

Furthermore, we will delve into the impact of sustainable bond issuances on stock prices (Tang and Zhang, 2020).

References

Bachelet, M. J., Becchetti, L., and Mandfredonia, S. (2019). The green bonds premium puzzle: the role of issuer characteristics and third-party verification. *Sustainability,* 11, 1-22. https://doi.org/10.3390/su11041098.

Baker, M., Bergstresser, D., Serafeim, G., and Wurgler, J. (2022). The Pricing and Ownership of US Green Bonds. *Annual Review of Financial Economics*, 14, 415-437. https://doi.org/10.1146/annurev-financial-111620-014802

Bouckaert, S., Fernandez-Pales, A., McGlade, C., Remme, U., Wanner, B., Varro, L., D'Ambrosio, D., and Spencer, T. (2021). Net Zero by 2050 – A Roadmap for the Global Energy Sector. International Energy Agency, Paris. https://trid.trb.org/view/1856381

Climate Bonds Initiative (2019). Climate Bonds Standard Version 3.0 https://www.climatebonds.net/climate-bonds-standard-v3

Ehlers, T., and Packer, F. (2017). Green Bond Finance and Certification. *BIS Quarterly Review*, September 2017.

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

Gianfrate, G., and Peri, M. (2019). The green advantage: Exploring the convenience of issuing green bonds. *Journal of Cleaner Production* 219, 127-135. https://doi.org/10.1016/j.jclepro.2019.02.022

Hachenberg, B., Schiereck, D. (2018). Are green bonds priced differently from conventional bonds? *Journal of Asset Management* 19, 371-383. https://doi.org/10.1057/s41260-018-0088-5

ICMA (2020). Sustainability-Linked Bond Principles. Voluntary Process Guidelines.

https://www.icmagroup.org/assets/documents/Regulatory/Green-Bonds/June-2020/Sustainability-Linked-Bond-Principles-June-2020-171120.pdf

ICMA (2021). Sustainable Bond Guidelines. updated 2021

https://www.icmagroup.org/assets/documents/Sustainable-finance/2021-updates/Sustainability-Bond-Guidelines-June-2021-140621.pdf

ICMA (2022a). Green Bond Principles. Voluntary Process Guidelines for Issuing Green Bonds. updated 2021 and June 2022 Appendix 1

https://www.icmagroup.org/sustainable-finance/the-principles-guidelines-and-handbooks/green-bond-principles-gbp/

ICMA (2022b). Social Bond Principles. Voluntary Process Guidelines for Issuing Social Bonds. updated 2021 and June 2022 Appendix 1

https://www.icmagroup.org/assets/documents/Sustainable-finance/2022-updates/Social-Bond-Principles_June-2022v3-020822.pdf

Karpf, A., and Mandel, A. (2018). The changing value of the 'green' label on the US municipal bond market. *Natural Climate Change* 8 (2), 161-165. https://doi.org/10.1038/s41558-017-0062-0

Kölbel, J.F. and Lambillon, A. (2023). Who Pays for Sustainability? An Analysis of Sustainability-Linked Bonds. Swiss Finance Institute. Research Paper Series, Nº23-07.

Larcker, D.F. and Watts, E.M. (2020). Where's the greenium? *Journal of Accounting and Economics* 69 (2-3), 101312. https://doi.org/10.1016/j.jacceco.2020.101312

Lyon, T.P. and Maxwell, J.W. (2021). Greenwash: corporate environmental disclosure under threat of audit. *Journal of Economics and Management Strategy* 20, 3-41. https://doi.org/10.1111/j.1530-9134.2010.00282.x

Nanayakkara, M. and Colombage, S. (2019). Do investors in green bond market pay a premium? Global evidence. *Applied Economics* 51 (40), 4425-4437.

Partridge, C. and Medda, F.R. (2020). The evolution of pricing performance of green municipal bonds. *Journal of Sustainable & Investment* 10 (1), 44-64. https://doi.org/10.1080/20430795.2019.1661187

Shi, X., Ma, J., Jiang, A., Wei, S. and Yue, L. (2023). Green bonds: Green investments or greenwashing? *International Review of Financial Analysis* 90, 102850. https://doi.org/10.1016/j.irfa.2023.102850

Tang D.Y., and Zhang, Y. (2020). Do shareholders benefit from green bonds? *Journal of Corporate Finance* 61, 101427. https://doi.org/10.1016/j.jcorpfin.2018.12.001

Torricelli, C. and Pellati, E. (2023). Social bonds and the "social premium". *Journal of Economics and Finance* 47, 600-619. https://doi.org/10.1007/s12197-023-09620-3

Wang, J., Chen, X., Li, X., Yu, J. and Zhong, R. (2020). The market reaction to green bond issuance: Evidence from China. *Pacific-Basin Finance Journal* 60, 101294. https://doi.org/10.1016/j.pacfin.2020.101294

Wu, Y. (2022). Are green bonds priced lower than conventional peers? *Emerging Markets Review* 52, 100909. https://doi.org/10.1016/j.ememar.2022.100909

Zerbib, O.D. (2019). The effect of pro-environmental preferences on bond prices: evidence from green bonds. *Journal of Banking & Finance* 98, 39-60. https://doi.org/10.1016/j.jbankfin.2018.10.012

Appendix 1

Baseline characteristics of the data we restrict the data to issuers of ESG bonds

Variables	Level	0	1	P	SMD
n		1,492,754	9,945		
OYTM. Mean (SD)		3.06 (9.8)	2.78 (2.4)	0.078	0.039
Amount million USD. Mean (SD)		41.699 (1956.6)	255.868 (647.4)	<0.001	0.147
Coupon Mean (SD)		3.79 (5.4)	3.47 (4.3)	<0.001	0.065
Maturity Mean in days (SD)		1,036.42 (1,501.7)	2,724.00 (10,597.6)	<0.001	0.223
Currency (%)	US Dollar	616,742 (41.3)	1,790 (18.0)	<0.001	0.988
	South Korean Won	201,394 (13.5)	768 (7.7)		
	Euro	199,249 (13.3)	2,204 (22.2)		
	Japanese Yen	140,670 (9.4)	695 (7.0)		
	Chinese Yuan	97,284 (6.5)	1,759 (17.7)		
Seniority	Senior preferred	19,492 (1.3)	386 (3.9)	<0.001	0.533
	Senior non-preferred	6,045 (0.4)	460 (4.6)		
	Secured	17,775 (1.2)	1,006 (10.1)		
	Unsecured	1,449,397 (97.1)	8,093 (81.4)		
Callable (%)	No	1,324,750 (91.0)	8,007 (81.5)	<0.001	0.281
	Yes	130,456 (9.0)	1,822 (18.5)		
Putable (%)	No	1,451,644 (99.7)	9,463 (96.0)	<0.001	0.261
	Yes	3,643 (0.3)	391 (4.0)		