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Stock market reaction to green bond issuance: evidence from the EU

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Abstract

Corporate green bonds have emerged as a pivotal instrument in sustainable finance and the European Union is one of the leading markets. This work investigates how the stock market responds to a corporate green bond issuance by focusing on the EU utility sector. Using an event study methodology in which the relevant date is the announcement day, I found a negative price reaction to green bond issuances. The average cumulative abnormal return (CAR), that was positive until 2019, sharply declined onwards along with an increase in volatility. Results show that CARs tend to be higher for first-time and certified issuances while the impact of the relative issue size on the market reaction seems to be negligible. In addition, the comparison between the yield at issue of green vs non green bonds suggests that the reaction is unlikely to be driven by a cost of capital argument.

Introduction

In the realm of sustainable finance, green bonds have emerged as a pivotal instrument for driving environmental progress by aligning economic and ecological objectives. Indeed, green bonds are fixed income instruments whose proceeds are directly committed to finance environmental projects. Although the earliest issuers of these securities were governments and development banks, it has also begun to be embraced by corporations, as green bonds combine companies' interests in raising new capital and in spreading a positive image of themselves by attracting investors who are sensitive to the environmental cause.

In the last decade, the corporate green bond market has surged dramatically on a global scale passing from around €15 bln to over €300 bln[1]. On the one hand, green bonds have attracted the attention of scholars who begun to study the characteristics of this market, delving into the driving geographies and industries as well as comparing green bonds with non green bonds in order to understand what motivations had led them to emerge as a major source of sustainable financing. On the other hand, institutions and regulators have been working to provide answers to questions such as: what are the requirements for a bond to be labeled as green? Are there any disclosure duties that a green bond issuer must meet? Who certifies a green bond? Who oversees compliance with the regulation? Indeed, a comprehensive regulatory framework that coherently answers these questions is essential to meet those investors who are genuinely interested in financing companies' green projects by purchasing green bonds. Great efforts in this direction have been made by the European Union. The EU, to date, is the largest market for green bonds, followed by the United States and China, and the euro is the leading issuing currency worldwide.

In this paper I analyze the EU corporate green bond market. First, I present the main characteristics of this market, highlighting aspects such as number and amount of green bonds issued, countries of incorporation, currencies, average coupon, average maturity and discuss how some of these features are influenced by the sector in which the green bond issuer operates. Then, I depict the current green bond regulations first at the international level and then at the EU level. In particular, I focus on the innovations introduced by the European Commission in recent years: the European Green Bond Standard and the EU Taxonomy of sustainable activities. Finally, I analyze the stock market reaction to green bond issuance using an event study methodology, as done by C. Flammer (2021). I also examine how this is affected by the first-time factor, by third-party certifications and by the relative

[1] Climate Bonds Initiative, 2024.

size of the issue. In particular, I study the case of the EU utility companies, as they are among the largest green bond issuers and exert a central role in the implementation of the green transition. Moreover, I make a brief comparison between green bonds and non green bonds to assess the existence of a possible greenium (i.e. green premium) in order to see whether or not the stock market reaction to green bond issuance is due to a cost of capital argument.

1 Corporate green bond market in the EU

According to the Climate Bonds Initiative (CBI), the global green bond market exceeded €530 bln in 2023. Around half of the green bonds are incorporated in the European region and more than 60% are issued by corporations, making the EU corporate green bond market the world's largest contributor. In this chapter I describe the main characteristics of the EU corporate green bond market, highlighting features such as number and amount of green bonds issued, countries of incorporation, currencies, average coupon, average maturity and I discuss how some of those attributes are affected by the industry in which the green bond issuer operates.

1.1 Dataset construction and composition

To originate the dataset of corporate green bonds issued in the EU, I extracted from Bloomberg's fixed income database all corporate bonds labelled as "green bonds" (precisely, where the field "Green Instrument Indicator" was set to "True"). I removed those bonds whose issuer's BICS (Bloomberg Industry Classification Standard) – Level 1 – was "Government" and included only bonds that are incorporated in one of the EU member states. A total of 3,026 corporate green bonds meeting the above criteria were issued from January 1, 2013 to December 31, 2023.

1.2 General features of the market

On July 5, 2007 the European Investment Bank issued its inaugural Climate Awareness Bond, the world's first green bond[2]. In November 2008 it was the World Bank to issue its first green bond, that served as the "blueprint for today's green bond market"[3], as it defined criteria of eligibility for green projects and added impact reporting as part of the process. It took several years before green bonds seriously permeated into the corporate world. Indeed, it was in 2013 that a real corporate green bond market began to establish itself through pioneering companies such as the French bank Crèdit Agricole and the Swedish real estate company Vasakronan.

[2] European Investment Bank, 2022, *15 years of EIB green bonds: leading sustainable investment from niche to mainstream.*
[3] The World Bank, 2018, *From Evolution to Revolution: 10 Years of Green Bonds.*

Table 1
Corporate green bonds issued in the EU over the years

Year	Bonds (#)	*Bonds (% of total)*	Amount (€ bln)	*Amount (% of total)*
2013	13	0.43%	2.09	0.30%
2014	54	1.78%	7.77	1.13%
2015	70	2.31%	16.50	2.40%
2016	72	2.38%	21.00	3.05%
2017	122	4.03%	33.68	4.89%
2018	170	5.62%	34.38	4.99%
2019	276	9.12%	68.73	9.98%
2020	455	15.04%	85.59	12.43%
2021	666	22.01%	140.56	20.41%
2022	599	19.80%	139.30	20.22%
2023	529	17.48%	139.19	20.21%
Total	3,026	100%	688.79	100%

Table 1 presents the number and amount of corporate green bonds issued in the EU member states during the period 2013-2023. In 2013 the EU corporate green bond issuances were only 13 for a total value of about €2 bln. Over the years the market increased sharply, especially during the period 2018-2021 where it showed a Compound Annual Growth Rate (CAGR) of almost 60%, reaching 666 new issuances for a value of about €140 bln. Since 2021 the annual amount issued remained quite stable, while the number of new issuances decreased, resulting in a 25% increase in the average amount issued per bond. Despite the slowdown in recent years, the market has shown solid growth over time and the favorable trend is expected to continue in the coming years[4]. Overall, in the period 2013-2023 a total of 3,026 green bonds have been issued by companies in the EU member states for a combined value of more than €680 bln.

[4] S&P Global, 2024, *Global green bond sales to get boost in 2024 as interest rates may fall*.

Table 2
Corporate green bonds in the EU: breakdown by country

Country	Bonds (#)	*Bonds (% of total)*	Amount (€ bln)	*Amount (% of total)*
Netherlands	225	7.44%	139.88	20.31%
Germany	748	24.72%	132.17	19.19%
France	526	17.38%	112.79	16.37%
Sweden	724	23.93%	61.58	8.94%
Spain	161	5.32%	58.42	8.48%
Italy	86	2.84%	44.92	6.52%
Denmark	75	2.48%	25.10	3.64%
Luxembourg	154	5.09%	25.04	3.64%
Finland	61	2.02%	19.43	2.82%
Austria	91	3.01%	18.54	2.69%
Ireland	29	0.96%	16.84	2.45%
Belgium	44	1.45%	10.64	1.54%
Portugal	14	0.46%	7.38	1.07%
Poland	15	0.50%	3.43	0.50%
Hungary	31	1.02%	2.98	0.43%
Greece	8	0.26%	2.36	0.34%
Czech Republic	5	0.17%	2.35	0.34%
Slovakia	9	0.30%	1.86	0.27%
Romania	7	0.23%	1.40	0.20%
Lithuania	4	0.13%	0.69	0.10%
Slovenia	1	0.03%	0.50	0.07%
Latvia	6	0.20%	0.43	0.06%
Estonia	1	0.03%	0.05	0.01%
Malta	1	0.03%	0.03	0.00%
Total	3,026	100%	688.79	100%

Looking at the breakdown of the EU corporate green bonds among countries, as shown in **Table 2**, it can be noted that the distribution is strongly skewed towards Western European countries. The Netherlands, Germany and France together account for more than 55% of the total amount issued in the EU member states. Among these three, The Netherlands is the country where corporate green bonds present the largest average amount per single issuance, whereas the smallest average amount is shown in Germany, mostly due to the presence of small size issuances operated by German private companies.

Table 3
Corporate green bonds in the EU: breakdown by currency

Currency	Bonds (#)	*Bonds (% of total)*	Amount (€ bln)	*Amount (% of total)*
Euro	1,776	58.69%	569.27	82.65%
US Dollar	222	7.34%	46.43	6.74%
Swedish Krona	665	21.98%	43.74	6.35%
Pound Sterling	30	0.99%	12.58	1.83%
Swiss Franc	38	1.26%	6.81	0.99%
Forint	29	0.96%	1.85	0.27%
Norwegian Krone	32	1.06%	1.46	0.21%
Yen	43	1.42%	1.43	0.21%
New Taiwan Dollar	25	0.83%	1.42	0.21%
Zloty	14	0.46%	0.72	0.10%
Romanian Leu	6	0.20%	0.69	0.10%
Australian Dollar	24	0.79%	0.60	0.09%
Turkish Lira	28	0.93%	0.28	0.04%
Danish Krone	18	0.59%	0.26	0.04%
Yuan Renminbi	4	0.13%	0.24	0.04%
Brazilian Real	18	0.59%	0.20	0.03%
Czech Koruna	5	0.17%	0.17	0.03%
Singapore Dollar	1	0.03%	0.17	0.02%
Indian Rupee	19	0.63%	0.11	0.02%
Russian Ruble	2	0.07%	0.10	0.02%
Hong Kong Dollar	2	0.07%	0.09	0.01%
Mexican Peso	7	0.23%	0.05	0.01%
New Zealand Dollar	2	0.07%	0.04	0.01%
Rand	9	0.30%	0.04	0.01%
Rupiah	6	0.20%	0.01	0.00%
Dong	1	0.03%	0.01	0.00%
Total	3,026	100.00%	688.79	100.00%

Table 3 shows the currency breakdown of the corporate green bond market in the EU. As might be expected dealing with the European Union, the vast majority of the corporate green bonds in the area under consideration is denominated in Euro. In particular, the Euro accounts for more than 82% of the market, followed by the US Dollar and the Swedish Krona both between 6-7%, while all other currencies together represent less than 5%. Compared with issues in other currencies, euro-denominated corporate green bonds have a larger average size per single issuance.

Table 4
Corporate green bonds in the EU: coupon, maturity and amount over the years

Year	Average coupon rate (%)	Average maturity (years)	Average amount (€ bln)
2013	2.46	5.27	0.16
2014	3.19	5.58	0.14
2015	2.83	6.81	0.24
2016	1.96	7.34	0.29
2017	2.52	14.78	0.28
2018	2.28	6.23	0.20
2019	2.22	11.91	0.25
2020	1.92	9.56	0.19
2021	2.06	11.00	0.21
2022	3.29	9.58	0.23
2023	4.63	7.69	0.26
Total	2.67	8.70	0.22

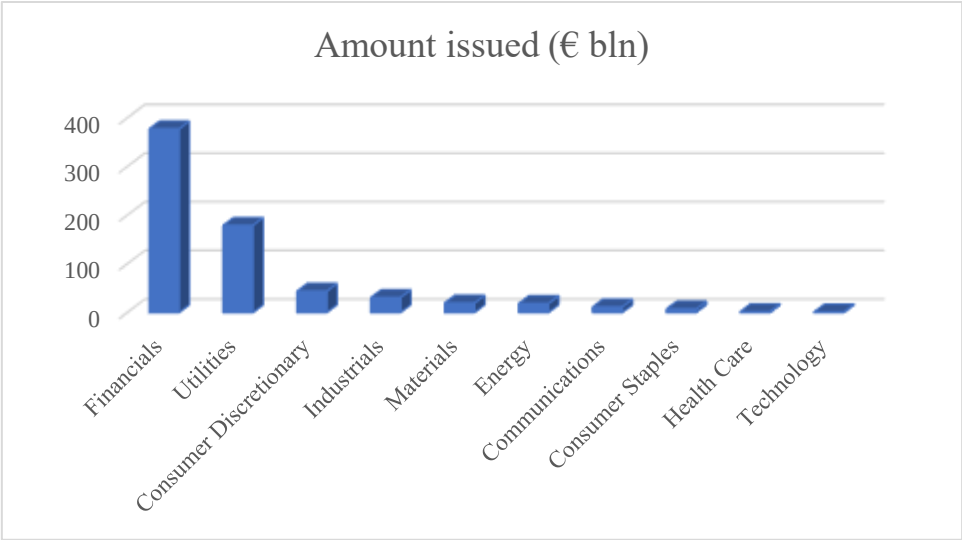
In **Table 4** are presented other relevant characteristics of the EU corporate green bond market and how they changed over time. All the three features, the average coupon rate, the average maturity and the average amount issued, were very volatile between 2013 and 2023. In particular, the average coupon rate ranged between 1.9% and 3.2% until 2021 and increased thereafter, as the two-year period 2022-3 was impacted by the rise in interest rates made by the ECB and other monetary authorities in the EU member states. The average maturity increased by more than 2 years in the period under consideration, reaching its peak in 2017 and starting decreasing from 2022. Similarly, also the average amount issued per single issuance augmented passing from €0.16 bln in 2013 to €0.26 bln in 2023.

1.3 Industry breakdown

In this part I present the industry breakdown of the EU corporate green bond market, as given by the BICS[5] – Level 1 –, and discuss the same characteristics as above distinguishing them among the different sectors, in order to assess whether or not corporate green bonds tend to exhibit different features depending on the industry in which the issuer operates.

[5] See 1.1 Dataset construction and composition.

Figure 1
Industry breakdown of corporate green bonds in the EU: amount issued



In **Figure 1** is presented the amount of corporate green bonds issued in the EU member states by the different industries over the period 2013-2023. As can be observed, the leading industry is that of the financials that account for about 55% of the market, followed by utilities with 26%, while the others combined account for less than 20% of the total. It is interesting to see that the leading sector is the financial, although green bonds issued by banks are somewhat different from those issued by other companies. Instead of investing the proceeds in green projects, banks invest them in green loans. Moreover, recent studies suggest that banks that issue green bonds reduce lending towards carbon-intensive sectors, but limited to the loan amounts granted in the role of lead bank in the deal[6]. As a result, investors may not be able to identify a clear link between the green bond issued by a financial institution and a specific green project. This is not usually the case for other industries that use green bond proceeds to finance specific environmental projects.

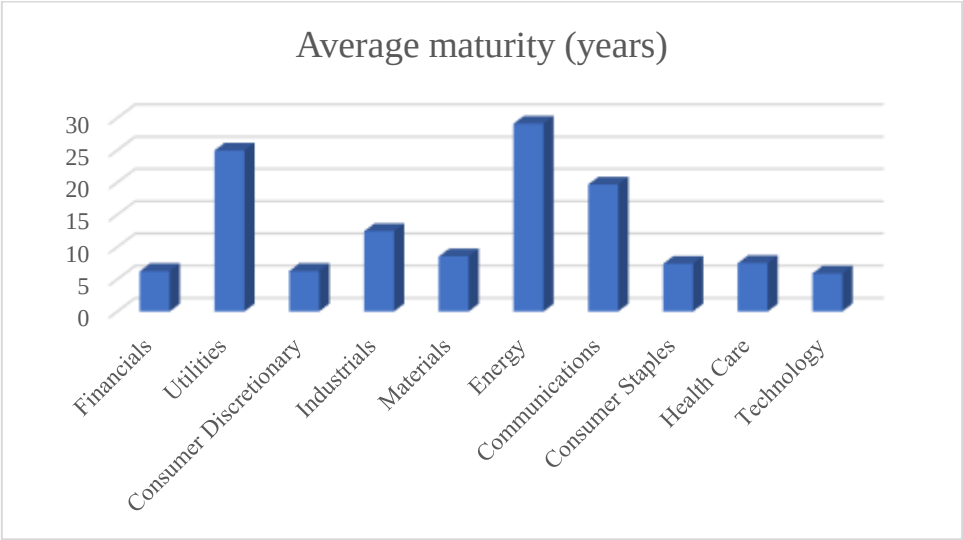
Even when looking at the number of green bonds issued, financial companies lead the way, with 2,201 issuances, followed, again, by utilities with 363. Considering the average size of the single issuance, utility companies have issued significantly larger green bonds with an average size that is around 3 times that of a financial.

[6] Fatica S., Panzica R., Rancan M., 2021, *The pricing of green bonds: Are financial institutions special?*. Journal of Financial Stability, 54.

Figure 2
Industry breakdown of corporate green bonds in the EU: average coupon rate

As far as the coupon rate is concerned, **Figure 2** shows that most of the industries tends to exhibit a similar rate, between 2% and 4%. Energy companies stand out with a 4.8% coupon rate, also due to the higher maturity of the issuances (see below).

Figure 3
Industry breakdown of corporate green bonds in the EU: average maturity



Finally, **Figure 3** shows the average maturity of EU corporate green bonds by industry. Utility and energy companies dominate the list, with an average maturity of around 25 years, followed by communications with almost 20 years. The others, on average, have less than 8 years of maturity.

It is important to note that the features presented above do not depend solely on the green label of the bond, but also on the structural characteristics of the different industries, in particular, with respect to the average size and maturity. However, it is still worth depicting how specific features of corporate green bonds change between industries, as these are important parameters in the decision-making process of any investor.

2 Regulatory framework

The corporate green bond market grew rapidly in the last decade, fueled by a widespread awareness of climate-related risks and investor attention on green themes. In order to increase market efficiency and reduce the costs for investors of assessing green bonds, several green bond regulations have been proposed.

Initially it was the international associations that promoted common principles and guidelines for green bond issuers to adopt on a voluntary basis. In 2014 the International Capital Market Association (ICMA) released the first version of the Green Bond Principles, a collection of best-practices to adopt when issuing bonds serving environmental purposes. In the same period the Climate Bonds Initiative (CBI) proposed a certification scheme for green securities, called the Climate Bonds Standard and Certification Scheme. More recently, EU institutions also stepped in by developing appropriate regulatory frameworks. In particular, the EU adopted the European Green Bond Standard[7], a common standard for green bonds available to investors in the Union, and the EU Taxonomy of sustainable activities[8], that defines criteria for economic activities that are aligned with a net zero trajectory by 2050.

In this chapter I first present the international initiatives of ICMA and CBI and then I depict the regulatory framework with the European Union.

2.1 International certifications

In 2014 the International Capital Market Association (ICMA) released the first version of the Green Bond Principles (GBP), a voluntary process guidelines for issuing green bonds, inheriting the work begun by a consortium of investment banks in the same year[9]. The GBP are part of ICMA's broader framework on sustainable finance, which also includes the Social Bond Principles (SBP), the Sustainability Bond Guidelines (SBG) and the Sustainability-Linked Bond Principles (SLBP). The

[7] Regulation (EU) 2023/2631 of the European Parliament and of the Council of 22 November 2023.
[8] Regulation (EU) 2020/852 of the European Parliament and of the Council of 18 June 2020, entered into force on 12 July 2020.
[9] Climate Bonds Initiative, 2023, *Green Bond Principles & Climate Bonds Standard*. The consortium was composed of Bank of America Merrill Lynch, Citi, Crédit Agricole Corporate and Investment Bank, JPMorgan Chase, BNP Paribas, Daiwa, Deutsche Bank, Goldman Sachs, HSBC, Mizuho Securities, Morgan Stanley, Rabobank and SEB.

GBP are aimed at promoting the role of global debt capital markets in financing progress towards environmental and social sustainability.

In particular, they seek to support issuers in financing environmentally sound projects that foster net-zero emissions economy and protect the environment. In the latest version of June 2021, the GBP are composed of four core arguments:

i) *Use of proceeds*. The cornerstone of a green bond is the use of its proceeds to finance eligible green projects, that should be appropriately described in the legal documentation of the security. In the event that all or part of the proceeds are used for refinancing, it is recommended that issuers provide an estimate of the share of financing vs re-financing and, were appropriate, also specify which investments are refinanced. Although the identification of green projects is not the focus of the GBP, they also provide an indicative (and non-exhaustive) list of green project categories. The following are included: renewable energy, energy efficiency, pollution prevention and control, environmentally sustainable management of living natural resources and land use, terrestrial and aquatic biodiversity, clean transportation, sustainable water and wastewater management, climate change adaptation, circular economy adapted products, production technologies and processes, certified eco-efficient products, green building;

ii) *Process for project evaluation and selection*. The issuer of a green bond should inform investors about: the environmental sustainability objectives of the eligible green projects, the process by which the issuer determines how the project fit within the eligible green projects categories and information on processes by which the issuer identifies potential environmental risks associated with the eligible green projects;

iii) *Management of proceeds*. The net proceeds[10] of the green bond, or an equal amount, should be credited by the issuer to a distinct account, portfolio or adequately tracked and attested internally by a formal process linked to the issuer's lending and investment operations for the eligible green projects. Throughout the period that the green bond is outstanding, the balance of the tracked net proceeds should be regularly adjusted to match the allocations to green projects made during the period. Transparency is encouraged and it is recommended the supervision of an external auditor to verify the management of proceeds;

[10] The net proceeds are given by the difference between the total bond proceeds and the issuance costs that are directly related to the issuance of the bond, including the cost of financial intermediaries leading the issuance, advisory, legal, rating costs and costs related to the external reviews.

iv) *Reporting*. Green bond issuers should provide public information on the use of proceeds, annually renewed until the full allocation and, in case of material developments, on a timely basis. The annual report should include the list of projects to which the green bond proceeds have been allocated and their expected impact as given by qualitative and quantitative indicators. It is also encouraged the use of a summary for which the ICMA provide a harmonized template.

The latest version of the GBP also includes an appendix related to four types of green bonds that are aligned with the principles: i) *Standard green use of proceeds bonds*, unsecured bonds with full recourse-to-the-issuer only, ii) *Green revenue bonds*, non-recourse-to-the-issuer bonds in which the credit exposure in the bond is to the pledged cash flows of the revenue streams, taxes, fees etc. and whose use of proceeds goes to related or unrelated green projects, iii) *Green project bonds*, project bonds for which the investor has direct exposure to the risks of the green projects with or without potential recourse to the issuer and iv) *Secured green bonds*, secured bonds where the net proceeds are applied to finance or refinance the green projects securing the specific bond only or the green projects of the issuer, originator or sponsor, that may or may not secure the specific bond in whole or in part.

Despite its role in promoting sustainable finance instruments, ICMA does not release certifications. It does, however, the Climate Bonds Initiative (CBI). CBI is a not-for-profit organization working to mobilize global capital for climate action. Its Climate Bonds Standard and Certification Scheme (CBS) certifies debt instruments, assets and, more recently, also entities that are aligned with the Climate Bonds Taxonomy, a framework of activities that is consistent with the 1.5°C warming limit of the Paris Agreement[11]. The CB Taxonomy consists of the following sectors:

i) *Energy*: solar, wind, geothermal, hydropower, marine renewables, electricity grids & storage, mixed energy (utilities);

ii) *Transport*: public passenger transport, private transport, freight rail, water-borne, biofuels for transport;

iii) *Water*: water monitoring, water storage, water treatment, water distribution, water desalination, flood defense, nature-based solutions;

iv) *Buildings*: residential, commercial;

[11] A legally binding international treaty on climate change, adopted by 196 parties at the UN Climate Change Conference on December 12, 2015 in Paris. The aim of the Paris Agreement is to contain the global average temperature increase well below 2ºC, preferably around 1.5ºC, above pre-industrial levels.

v) *Land use & marine resources*: crop production, livestock production, commodity supply chains, commercial forestry, ecosystem conservation & restoration;

vi) *Industry*: cement production, steel production, basic chemicals production, specialist & intermediate chemicals, hydrogen production, storage & transport, critical raw materials, carbon capture storage;

vii) *Waste*: preparation, reuse, recycling, biological treatment, waste to energy, landfill.

Over the years, CBI has certified more than 10,000 green bonds for over €237 bln from approximately 25 countries[12]. In addition to serving as a third-party certifier of financial instruments, CBI produces research papers and collaborates with national authorities to promote sustainable finance policies and harmonize green standards among countries. In particular, the Climate Bonds Standard has been instrumental in the development of the EU Taxonomy for Sustainable Finance[13].

2.2 Regulatory framework in the EU

The urgence to promote transparency and reliability on green financial instruments has been particularly felt within the EU, where political bodies, supported by the European Central Bank, established a harmonized regulatory framework for EU member states. The green bond framework is currently composed of the European Green Bond Standard and the EU Taxonomy of sustainable activities.

2.2.1 European Green Bond Standard

Regulation 2023/2631 on European Green Bonds (EuGB Regulation) has established for the first time a common standard for green bonds available to investors in the Union. The EuGB Regulation was published on November 22, 2023, after approval by the EU Parliament and the Council, based on the consideration that the "transition to a climate-neutral, sustainable, energy - and resource - efficient, circular and fair economy is key to ensuring the long-term competitiveness of the economy of the Union and the well-being of its peoples".

[12] Climate Bonds Initiative, 2022, *Mobilising Capital for Climate Action.*
[13] EU Technical Expert Group on Sustainable Finance, 2020, *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance.*

The EuGB Regulation:

i) establishes uniform requirements for issuer of bonds who want to use the designation "European Green Bond" or "EuGB" for their bonds that are made available to investors in the Union;

ii) lays down a system to register and supervise external reviewers of European Green Bonds;

iii) provides optional disclosure templates for green bonds and sustainability-linked bonds within the Union.

In order to do so, it requires that:

i) before the maturity of a European Green Bond, its proceeds shall be fully allocated to specific categories in accordance with the taxonomy requirements. For every 12-month period until the date of full allocation of the proceeds and, where applicable, until completion of the CapEx plan, issuers of EuGBs shall draw up a EuGB allocation report, demonstrating their correct allocation. Before the issuance of a European Green Bond, issuers shall complete the EuGB factsheet and receive a positive opinion to a pre-issuance review by an external reviewer. After the issuance of a European Green Bond, it is required a post-issuance review by an external expert on the correct allocation of the bond proceeds by the issuer. After the complete allocation of the proceeds and at least once over the lifetime of the bonds, issuers of EuGBs shall draw up and make public a EuGB impact report on the environmental impact of the utilization of the bond proceeds. In order to use the designation EuGB the issuer shall specify it in the bond prospectus. Further specific conditions are required for securitization bonds;

ii) external reviewers for European Green Bonds shall, before taking their activities, be registered with ESMA[14] that accept an applicant as external reviewer only if they have sufficiently good repute, professional qualification, relevant experience and fulfill appropriate organizational and governance requirements. A third-country external reviewer may provide its services, in accordance with this Regulation, to issuers of European Green Bonds where that third-country external reviewer is registered in the appropriate register of third-country external reviewers kept by ESMA. Supervisory and investigatory tasks and powers are attributed to the competent authority of the home

[14] European Securities and Markets Authority.

member state and ESMA[15]. They can impose administrative penalties and take other appropriate measures which shall be effective, proportionate and dissuasive;

iii) by December 21, 2024, the Commission shall publish guidelines establishing templates for voluntary pre-issuance disclosures for issuers of bonds marketed as environmentally sustainable and of sustainability-linked bonds. Issuers of environmentally sustainable bonds and issuers of sustainability-linked bonds may provide periodic disclosure of post-issuance information in accordance to common templates.

Summarizing, the EuGB Regulation establishes uniform rules for European Green Bonds, with a direct reference to the EU Taxonomy for sustainable activities and entrusts national competent authorities and ESMA with supervisory tasks and powers, in order to improve transparency and facilitate the comparability of green bonds. This, in turn, facilities capital raising for projects that pursue environmentally sustainable objectives, while contributing to the integrity of the market.

2.2.2 EU Taxonomy

In any regulatory framework, it is essential to clearly define the object of the regulation. In the case of EuGB Regulation, it is the EU Taxonomy on sustainable activities that defines which projects a bond must finance in order for it to be labeled as green. The Taxonomy helps scale up investments in green projects, protect investors from greenwashing, supports companies to plan and finance their green transition and mitigates market fragmentation and information asymmetry.

The EU Taxonomy on sustainable activities has been established with the Regulation (EU) 2020/852 of the European Parliament and of the Council of June 18, 2020, entered into force on July 12, 2020. It is the result of joint work between multiple parties, as the Technical expert group on sustainable finance (TEG), appointed by the European Commission, included contributors from several companies such as Climate Bonds Initiative, ICMA, Bloomberg, BNP Asset Management, Borsa Italiana, MSCI, Nordea, Luxemburg Stock Exchange et al.[16]. Specifically, the EU Taxonomy defines criteria for economic activities that are aligned with a net zero trajectory by 2050 (and the broader

[15] The Court of Justice shall have unlimited jurisdiction to review decisions whereby ESMA has imposed a fine or a periodic penalty payment pursuant to this Regulation. It may annul, reduce or increase the fine or periodic penalty payment imposed.
[16] EU Technical Expert Group on Sustainable Finance, 2020, *Taxonomy: Final report of the Technical Expert Group on Sustainable Finance*.

environmental goals other than climate), in order to achieve the EU's 2030 climate and energy targets for 2030 and fulfill the objectives of the European Green Deal[17].

According to the EU Taxonomy, an economic activity shall qualify as environmentally sustainable when it:

i) contributes substantially to one or more of the following environmental objectives: climate change mitigation, climate change adaptation, the sustainable use and protection of water and marine resources, the transition to a circular economy, pollution prevention and control, the protection and restoration of biodiversity and ecosystems;

ii) does not lead to a lock-in of assets that undermine long-term environmental goals, considering the economic lifetime of those assets;

iii) has a substantial positive environmental impact, on the basis of life cycle considerations;

iv) does not significantly harm any of the environmental objectives set out in the first point, considering the environmental impact of the activity itself and the environmental impact of the products and services provided by that activity over their life cycle;

v) is carried out in compliance with the minimum safeguards laid down in accordance with the OECD Guidelines for Multinational Enterprises and the UN Guiding Principles on Business and Human Rights, including principles set out in the Declaration of the International Labour Organisation on Fundamental Principles and Rights at Work and the International Bill of Human Rights;

vi) complies with technical screening criteria that have been established by the Commission in the Taxonomy Delegated Acts.

In order to make the contents of the EU Taxonomy easier to access and consult to the general public, it has been published in the European Commission website the EU Taxonomy Navigator, a system that offers a series of online and user-friendly tools. Among those there is the EU Taxonomy Compass, which enables users to check which activities are Taxonomy-eligible (giving specific NACE and numbers codes), to which objective they substantially contribute and what criteria have to be met for activities to be considered Taxonomy-aligned. The Navigator includes also the EU Taxonomy Calculator that help users understand the reporting obligations laid down in the Disclosures Delegated Act under Article 8 of the EU Taxonomy Regulation. In particular, under Article 8 of the EU Taxonomy Regulation large enterprises, required to publish non-financial

[17] Reducing net greenhouse gas emissions by at least 55% by 2030, compared to 1990 levels.

information under the Corporate Sustainability Reporting Directive (CSRD), must disclose information on how and to what extent their activities are related to environmentally sustainable economic activities. For this purpose, the Disclosures Delegated Act establishes the key performance indicators related to turnover, capital expenditures and operating expenditures that non-financial enterprises must report. Finally, the Navigator includes the EU Taxonomy User Guide, a simple guide on the Taxonomy for non-experts that explains what the EU Taxonomy is and how it fits within the wider EU policy landscape.

3 Stock market reaction to green bond issuance

In this chapter I discuss whether and how the public announcement of a green bond emission in the EU member states affect the company's share price. In order to answer these questions, I decided to focus my attention on utility companies, because: i) they are one of the largest contributors to the corporate green bond market in the EU and ii) they are expected to be a significant driver of investor attention to green issues, as they provide essential services to the daily lives of the public and are crucial to promote and realize the transition towards a green and sustainable economic system[18].

After briefly presenting the dataset, I explain the event study methodology used to capture the stock market reaction to the announcement of green bond issuances. Then, I discuss the results, highlighting how those change considering key aspects of the green bond emission. In particular, I present three factors: i) the "impact factor" related to the first issuance of green bond by a public company, ii) the "credibility factor" linked to the third-party green certifications of the bond and iii) the "commitment factor" related to the relative size of the issue with respect to the market capitalization of the issuer. Finally, I match green bonds with their corresponding non green bonds, comparing the yield at issue of the two, in order to assess the existence of a green bond premium.

3.1 Dataset construction and composition

The dataset used in this section is originated from the one presented in the first chapter[19]. I extracted from that all the issuing companies operating in the utility sector (precisely, where the field "Bloomberg Industry Classification Standard" - Level 1 - was labelled as "Utilities"). I obtained 363 bonds issued by 84 corporations. Then, I removed private corporations and those whose issue was not publicly announced, whereby the final dataset is composed of 118 bonds issued by 20 utility companies.

3.2 Event study methodology

The event study methodology used in this section is similar to the one presented by Caroline Flammer in her paper published in January 2021 on the Journal of Financial Economics, titled Corporate Green

[18] After China, EU is the major economy for 2023 energy transition investments according to BloombergNEF Report.
[19] See 1.1 Dataset construction and composition.

Bonds[20]. The aim of this methodology is to examine the stock price reaction towards a specific event. In this case the relevant date for the event study methodology is the announcement day, the day on which companies publicly announce that they are going to issue green bonds. This is because it is with the announcement of the issuance that companies provide the market with new information, while on the issuance date companies simply place in the market their previously announced securities. Therefore, according to the Efficient Market Hypothesis (EMH)[21] prices are expected to move only around the first date and not be subject to relevant changes near the second one.

In the following analysis of corporate returns, the announcement date is the event date (day 0). As it is plausible that some information may have reached the public before the announcement date and accounting for the possibility of a staggered reaction of the market, in accordance with Flammer (2021) and Krueger (2015), I focused my attention on the event window [-5,10]. In order to investigate whether there is a significant price variation before and after the relevant event window, I also included the time intervals [-20, -11], [-10, -6] with respect to pre-issuance movements and [11, 20], [21, 60] with respect to post-issuance movements.

Firstly, I estimated the coefficients α_i and β_i. They were obtained by the Ordinary Least Squares (OLS) method based on the 200 trading days preceding the first interval [-20, -11] using daily returns. This means that the trading days used in the regression go from 220 days before the announcement date to 21 days prior to it, corresponding to the time interval [-220, -21]. Formally, the regression is the following:

$$R_{it} = \alpha_i + \beta_i * R_{mt} + \varepsilon_{it}$$

R_{it} is the stock return for company i on day t; R_{mt} is the daily market return; ε_{it} is the residual. I computed the market return using the daily prices of the Euro Stoxx 50 Index[22], as it is the main equity index in the Eurozone.

I used the coefficients obtained from the above regression to compute the estimated return of company *i* on day *t*. Formally, this is given by:

$$\hat{R}_{it} = \hat{\alpha}_i + \hat{\beta}_i * R_{mt}$$

[20] Flammer C., 2021, *Corporate green bonds.* Journal of Financial Economics, 142, pp. 499-516.
[21] Fama E. F., 1970, *Efficient Capital Markets: A Review of Theory and Empirical Work.* The Journal of Finance, 25 (2), pp. 383–417. According to the EMH current stock prices reflect all existing available information.
[22] Euro Stoxx 50 represents the 50 most capitalized stocks in the Eurozone. As it is a generalist and multi-sectorial index, in order to assess the robustness of the results, it will be later used the Euro Stoxx Utilities, a sub-index of the Euro Stoxx focused on the utility sector.

Then I calculated the abnormal daily return (AR) of company *i* on day *t* as follows:

$$AR_{it} = R_{it} - \hat{R}_{it}$$

I computed the cumulative abnormal return (CAR) of company *i* for each time interval by summing up the abnormal returns within that interval. I performed this for the periods [-20, -11], [-10, -6], [11, 20], [21, 60] and [-5, 10]. Let [s, m] be the event window, the cumulative abnormal return for firm *i* from s to *m* is:

$$CAR_i = \sum_{t=s}^{m} AR_{it}$$

I finally computed the average CAR for each time interval.

3.3 Results

Empirical evidence shows that while equity issues tend to have a negative effect on the share price of the issuer, bonds do not have a significant impact[23]. This is because when a company issue new shares, dilution makes the price fall. Conversely, market reaction to bond issues tends to be more modest and related to different factors, such as: amount issued, existing financial position, yield and current market perception. This is consistent with the Pecking Order Theory of Myers and Majluf (1984)[24] according to which managers, who have more information than the general public about their company, tend to prefer financing with debt rather than equity.

Differently from a traditional bond (non green plain-vanilla bond), a green bond announcement entails two pieces of information: i) a bond issuance ii) a market signal of the company's commitment to have a positive environmental impact. Since the stock market is typically unresponsive to traditional bond issues, the reaction to green bond issuances is likely to reflect the latter component. As can be seen in **Table 5,** the average CAR in the event window [-5, 10] is around -1.6%, suggesting that utility companies tend to react negatively to the announcement of green bond issuance.

[23] Eckbo B. E., Masulis R. W. and Norli O., 2007, *Security Offerings*. Handbook of Corporate Finance, Vol. 1, B. E. Eckbo, ed., Chapter 6, pp. 233-373, Elsevier/North-Holland Handbook of Finance Series, 2007.
[24] Myers S., Majluf N., 1984, *Corporate financing and investment decisions when firms have information that investors do not have*. Journal of Financial Economics 13, pp. 187-221.

Table 5
Stock market reaction to green bond issuance

Event time	CAR (%)	Std. err. (%)
[-20, -11]	-1.295	5.177
[-10, -6]	-0.509	4.733
[-5, 10]	-1.565	8.156
[11, 20]	0.442	5.033
[21, 60]	0.340	10.958

These results deviate from previous studies that show how the stock price reaction to a green bond announcement is generally positive (Flammer 2021, Tang and Zhang 2020, Glavas D. 2020). This could be due to several reasons, including: i) a geographical factor, as previous literature typically investigated on a global (or non-European) scale while this study focuses on green bonds in EU member states, ii) an industry factor, as prior papers examined the event on a multi-industry level (or, at least, without a focus on utilities) and iii) a time horizon factor, as main studies in the topic date back to 2020-2021, with data about the green bond market up to 2018-2019, while this paper included also issuances until the end of 2023.

Among the three, the one that is most likely to explain the difference in results from previous work is the time horizon argument. In fact, data show that there is a strong and positive market reaction to green bond issuance until 2019. The average CAR changed sign starting from 2020 and dramatically decreased in 2022 reaching a value of -5.7%. Results are shown in **Table 6**. Until 2019 the average CAR in the EU utility sector was about 1.3%, while in the period 2020-2023 it declined to -2.9%.

Table 6
Stock market reaction to green bond issuance: how it changed over time

Year	CAR [-5, 10] (%)	Std. err. (%)
2014	0.965	6.798
2017	-0.260	4.243
2018	1.231	4.271
2019	1.986	5.247
2020	-1.968	12.500
2021	-1.821	10.042
2022	-5.726	4.864
2023	-2.358	6.420

This could be due to several factors: i) the 2020 stock market crash caused by the Covid-19 pandemic and the shifted investors' attention from green bonds to other sustainable finance instruments. In fact, in that period, the growth of social bonds outpaced that of green bonds, portending a pivot away from

a historically climate-centric sustainable debt space and reflecting a diversification of sustainability objectives financed by investors[25], ii) the subsequent rally of financial markets, driven by stimulus fiscal and monetary policies to support economies and renewed investors' confidence, that increased stock prices volatility and iii) the evolution towards a more mature green bond market, where the novelty of the green label begin to fade as supply increases.

3.3.1 First-time vs subsequent issues

Following previous studies on the topic, I decided to check whether the stock market reaction to a green bond issuance tends to be different for first-time vs subsequent issues. Because of that, I divided the dataset of results between first-time and seasoned issues of the same issuer. As **Table 7** shows, first-time issues exhibit a significantly stronger performance. This suggests the existence of an "impact factor" as the company provides for the first time to the market the signal for its commitment to the environment. This supports the view that the maturation of the green bond market may have affected the negative stock market reaction.

Table 7
Stock market reaction to green bond issuance: first-time vs seasoned

	CAR [-5, 10] (%)	Std. err. (%)
First-time issue (N=20)	0.718	4.109
Seasoned (N=98)	-2.031	7.076

3.3.2 Certified vs non-certified green bonds

As previously discussed in chapter 2[26], companies have nowadays the possibility to certify their green bonds from respectable international associations, like the Climate Bonds Initiative. I call the presence of a green bond third-party certification a "credibility factor", as it increases corporate transparency and accountability for the nature of the instrument and the correct use of its proceeds. **Table 8** shows that certified green bonds (i.e. green bonds that exhibit the Climate Bonds Certification) have on average a better performance than those that are non-certified. However, the sample of certified green bonds is very small and the standard error quite high. Lack of third-party

[25] S&P Global, 2020, *A Pandemic-Driven Surge In Social Bond Issuance Shows The Sustainable Debt Market Is Evolving*.
[26] See 2.1 International certifications.

certifications could arguably be one of the causes for the negative reaction of the market and, hence, certifications could be an interesting resource for issuers.

Table 8
Stock market reaction to green bond issuance: certified vs non-certified

	CAR [-5, 10] (%)	Std. err. (%)
Certified (N=5)	-1.042	7.395
Non-certified (N=113)	-1.589	8.188

3.3.3 Large vs small relative issues size

In addition to previous studies, I decided also to assess whether the relative size of the issue with respect to the market capitalization of the issuer has an impact on the market reaction to green bond issuance. As for the market capitalization, I considered its value 21 days before the announcement day, so on the day prior to the first time interval. **Table 9** shows that there is not a strong relationship between the relative size of the issue and the market reaction. Thereby, the "commitment factor" represented by the relative amount of resources that will be directed to environmental friendly activities, seems not to provide a credible signal to the market.

Table 9
Stock market reaction to green bond issuance: ratio of amount issued to market capitalization

	CAR [-5, 10] (%)	Std. err. (%)
Above median	-1.547	7.532
Below median	-1.584	8.736

3.4 Robustness test

In order to verify the results presented in the previous part, I carried out another regression to compute the CARs of the stock prices around the announcement date of green bond issuances. In this case, rather than using the Eurozone generalist index Euro Stoxx 50, I used the sub-sectorial index Euro Stoxx Utilities.

As can be seen in **Table 10** and **Table 11**, there is, again, a general negative stock market reaction around the announcement date of green bond issuance, as the average CAR in the window [-5, 10]

amount to about -0.9%. Similarly to the previous case, we see that the stock market reaction was positive until 2019, and changed sign from 2020, accompanied by increased volatility of cumulative abnormal returns.

Table 10
Stock market reaction to green bond issuance – Euro Stoxx Utilities

Event time	CAR (%)	Std. err. (%)
[-20, -11]	-1.199	4.874
[-10, -6]	-0.097	3.419
[-5, 10]	-0.931	7.446
[11, 20]	1.010	4.693
[21, 60]	0.144	10.317

Table 11
Stock market reaction to green bond issuance: how it changed over time – Euro Stoxx Utilities

Year	CAR [-5, 10] (%)	Std. err. (%)
2014	0.986	5.454
2017	1.205	1.873
2018	2.262	2.061
2019	2.923	4.120
2020	-2.310	12.476
2021	-1.479	8.407
2022	-4.618	5.895
2023	-1.598	4.957

As in the case where we used the Euro Stoxx 50 to run the regression, we have that the "impact factor" (**Table 12**) is the factor that mostly affects the market reaction to green bond issuance. In fact, first-time issues exhibit much favorable CARs around the announcement date, with respect to subsequent issues. On the other hand, the "credibility factor" and "commitment factor" appear less relevant and even in contrast to the previous case, as shown in **Table 13** and **Table 14**.

Table 12
Stock market reaction to green bond issuance: first-time vs seasoned – Euro Stoxx Utilities

	CAR [-5, 10] (%)	Std. err. (%)
First-time issue (N=20)	0.993	4.794
Seasoned (N=98)	-1.324	6.177

Table 13
Stock market reaction to green bond issuance: certified vs non-certified – Euro Stoxx Utilities

	CAR [-5, 10] (%)	Std. err. (%)
Certified (N=5)	-1.113	7.322
Non-certified (N=113)	-0.923	7.451

Table 14
Stock market reaction to green bond issuance: ratio of amount issued to market capitalization – Euro Stoxx Utilities

	CAR [-5, 10] (%)	Std. err. (%)
Above median	-0.984	7.267
Below median	-0.878	7.620

3.5 Is there a premium for corporate green bonds?

The greenium refers to pricing benefits for sustainable debt issuer, based on the logic that investors are willing to pay extra or accept lower yields in exchange for sustainable impact[27]. Literature on greenium presents mixed results. Karpf and Mandel (2017)[28] found a green bond discount (i.e. a positive yield differential for green bonds compared to brown bonds) of about 0.08%, Zerbib (2019)[29] found a premium of about 0.02% and, more recently, the ESMA (2023)[30] found no systematic existence of a greenium. Larcker and Watts (2020)[31] argued that the mixed evidence on the greenium could be the result of methodological design misspecifications that produce biased estimates and they proposed a very tight matching methodology to assess the existence of a green bond premium.

In this part I follow Lacker and Watts's methodology to verify the presence of a corporate green bond premium in the EU utility sector. First, I extracted from the dataset used in the previous part[32] those bonds with non missing information of the offering yield (precisely that presented a positive value for the item "yield at issue" in Bloomberg's fixed income database). A total of 53 bonds have this information, corresponding to 12 unique issuers. For each of these issuers I extracted from Bloomberg's fixed income database all brown bonds that were issued between January 1, 2013 and December 31, 2023 and that have non missing information on the offering yield. I then matched each

[27] United Nations Development Programme, 2022, *Identifying the "greenium".*
[28] Karpf A., Mandel A., 2017, *Does it pay to be green? A Comparative Study of the Yield Term Structure of Green and Brown Bonds in the US Municipal Bonds Market.*
[29] Zerbib, O.D., 2019. *The effect of pro-environmental preferences on bond prices: evidence from green bonds*. Journal of Banking and Finance 98, pp. 39–60.
[30] ESMA, 2023, *The European sustainable debt market – do issuers benefit from an ESG pricing effect?.*
[31] Larcker D. F., Watts E. M., 2020, *Where's the greenium?.* Journal of Accounting and Economics.
[32] See 3.1 Dataset construction and composition.

green bond to a similar brown bond of the same issuer, excluding those that did not have a precise match. The matching is done with a two-step approach. First, I require the credit rating to be the same, using Bloomberg's composite credit rating. Then, I pick the nearest neighbor (using the Mahalanobis distance) based on four characteristics: i) log(issuance amount), ii) maturity, iii) coupon and iv) the number of days in between the green and brown bond issuance.

Results are provided in **Table 15** that shows how the EU corporate green bonds in the utility sector provide a discount rather than a premium, i.e. they seem to represent a more expensive source of financing for companies. However, as presented in the table, the difference is statistically insignificant (p-value= 0.7), in line with previous works that showed no statistically significant difference among the two[33]. These results also imply that the negative stock market reaction to the announcement of a green bond issuance is unlikely to be driven by a cost of capital argument, as green bonds are neither a more expensive nor a cheaper source of financing than matched brown bonds.

Table 15
Yield at issue of green bonds vs brown bonds

	Observations (#)	Mean (%)
Green bond	13	3.622
Matched non green bond	13	3.553
Difference		0.069
p-value (difference)		0.773

[33] Flammer C., 2021, *Corporate green bonds.* Journal of Financial Economics, 142, pp. 499-516 and Larcker D.F., Watts E.M., 2020, *Where's the greenium?* Journal of Accounting and Economics, 69, 101312.

Conclusion

Sustainable finance is about transforming finance to finance the transformation of the economy in a sustainable direction. This is how Fabio Panetta, current governor of the Bank of Italy, opened his speech at the 50th anniversary of the Italian Association for Financial Analysis. Green bonds, fixed income instruments whose proceeds are committed to finance environmental projects, are certainly part of this transformation. The green bond market has surged over time, driving the growth of sustainable finance instruments, especially in the EU, where most of the green bonds are incorporated. This paper belongs to the literature of green bond studies, which also includes the work of C. Flammer (2021), Tang and Zhang (2020), Glavas D. (2020) and discuss the EU corporate green bond market in light of its most recent developments.

The EU green bond market has grown rapidly in the last decade. New issuances have forcibly grown until 2021, then stabilized at around €140 bln per year. Most of the EU green bonds are denominated in euros and incorporated in Western European countries. With regard to the sector of the issuers, about 80 percent of green bonds are issued by financial or utility companies.

In the international landscape, the EU regulatory framework on green bonds is a leading example in terms of comprehensiveness and simplicity. It is composed of the European Green Bond Standard and the EU Taxonomy on sustainable activities. The former governs a common system of requirements, disclosure and supervision for all bonds available to investors in the Union whose issuer wishes to adopt the European Green Bond label. The latter specifies criteria under which an activity can be considered sustainable and indicates which specific sectors are sustainable.

As far as the stock market reaction to green bond issuances is concerned, results show that the price of an EU utility company tends to respond negatively to the announcement of a green bond issuance. In particular, until 2019, the announcement of a green bond issuance was perceived by the market as a positive signal, in line with previous studies (Flammer et al. 2021). However, a break in this trend emerges from 2020 onward, accompanied by a significant increase in volatility. In addition, it emerges that first-time and certified issues show on average better returns than subsequent and non certified issues, while the relative issue size seems to produce a negligible effect. These findings are robust even when the model uses a sectoral index like the Euro Stoxx Utilities rather than a geographic one as the Euro Stoxx 50. Finally, the comparison between the yield at issue of green vs non green bonds suggests that the reaction is unlikely to be driven by a cost of capital argument.

Further studies in this direction may analyze the behavior of green bonds in light of the recent adoption of the European Green Bond Standard by the European Commission. In particular, it will be possible to study how the EuGB label may impact the market reaction to the announcement of a green bond issuance and whether EuGB issuers may eventually have access to a cheaper source of financing.

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