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Exploring the determinants of corporate green bond issuance and its environmental implication: The role of corporate board

C. José García [a,*], Begoña Herrero [a], José Luis Miralles-Quirós [b], Maria del Mar Mirallles-Quirós [b]

[a] University of Valencia, Department of Corporate Finance, Av. dels Tarongers s/n, 46022, Valencia, Spain
[b] Faculty of Economic and Business Sciences, University of Extremadura, 06006 Badajoz, Spain

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ABSTRACT

The exponential growth of the green bond market has generated an incipient debate in the literature about the causes and implications for companies employing this green financing. An unexplored issue is the role of the board. In this context, the aim of this research is two-fold. Firstly, we analyse whether companies that have issued green bonds during the 2013–2021 period are characterised over the previous two years by having certain corporate governance characteristics, such as having a sustainability committee or a board with a higher percentage of women. Secondly, we examine whether these companies improve their environmental performance post-issuance by considering these governance characteristics, as well as the certification of green bonds and the purpose of the funds. For this purpose, we employ up to five alternative environmental performance variables. Our overall results indicate that companies that issue green bonds have a higher environmental score, a lower volume of CO_2 emissions, a board with a higher percentage of women and a sustainability committee. Moreover, such companies continue to perform certain environmentally friendly actions in the years after issuance. Furthermore, the results reflect that companies with poorer environmental scores may be using external certification of their emissions to improve their image.

1. Introduction

The consequences for the planet of climate change have led to the progressive adoption of environmental responsibility measures aimed at boosting sustainable development in all areas of society and the economy.

On a business level, corporate social responsibility programmes have been implemented focusing on environmental issues such as reducing CO_2 emissions, the reuse and recycling of waste and the reduction of water and energy consumption, among others. These measures are strategic and long-term and their implementation requires the use of a large number of financial resources. As a result, in recent decades the financial markets have developed financial strategies and products aimed at managing the financing of projects to boost sustainable development.

This is the context in which green bonds emerged. These are a type of bond similar to conventional bonds with the additional feature that the financing obtained must be used to finance or refinance green investments (Maltais and Nykvist, 2020). The issuance of green bonds therefore implies a company's commitment to sustainable development. According to signalling theory, the company publicly declares its commitment to the environment and with the issuance seeks not only funding but also the ability to send out credible signals about its environmental commitment to society and demonstrate its intention to improve its carbon footprint (Flammer, 2021; Yeow and Ng, 2021).

The first green bond was issued in 2007 by the European Investment Bank. However, the green bonds market did not take off until 2014. One key factor in this growth was the publication in that year of the Green Bond Principles (GBP) written by the International Capital Market Association (ICMA). Although a voluntary guide for issuers, these offer a series of best practice recommendations that promote integrity and increase investor confidence. Moreover, the signing of the Paris Agreement in 2015 and the United Nations Sustainable Development Goals (SDGs) have given a significant boost to the issuance of green bonds. Specifically, the objectives of the Paris Agreement included reducing greenhouse gas emissions to limit global warming and increasing the economy's ability to adapt to the adverse effects of climate change by encouraging the financing of investments related to these aspects. Since

* Corresponding author.
E-mail addresses: cjgm@uv.es (C.J. García), begona.herrero@uv.es (B. Herrero), miralles@unex.es (J.L. Miralles-Quirós), marmiralles@unex.es (M. del Mar Mirallles-Quirós).

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then, we have seen huge growth in the green bond market, rising from an issuance volume of less than USD 50 billion in 2015 to USD 452.2 billion in 2021 (Climate Bond Initiative, 2021). This growth has also been reflected in the number of issuing companies and countries, as stated by Cortellini and Panetta (2021).

The literature on the subject has developed alongside the growth of the market. Much of the previous evidence has focused on the characteristics of issuances (volume of funds, yield, cost, duration), as well as on market trading and investors (Chiesa and Barua, 2019; Russo et al., 2021; Nanayakkara and Colombage, 2021). Through green bonds, a company can attract socially responsible investors who not only seek to maximise their wealth but also want a model offering sustainable growth and a commitment to society and the environment. Various studies, such as those of Ehlers and Packer (2017), Zerbib (2019), MacAskill et al. (2021) and Pástor et al. (2022), have noted the existence of a negative green premium or "greenium" (lower yield for a green bond than for a conventional bond), highlighting the existence of environmental preferences among investors rather than just a financial motivation when investing. However, other authors such as Hachenberg and Schiereck (2018), Larcker and Watts (2020), Fatica et al. (2021) and Flammer (2021), have not found evidence of a green bond premium in either corporate green bonds or municipal green bonds, concluding that green projects generate competitive returns and are priced accordingly.

Other authors have focused on the issuing companies. Some authors have analysed whether the issuance of green bonds has been used for greenwashing purposes, that is, to make it appear that the company is more environmentally aware than it really is, or whether they are really sending a credible signal to their stakeholders regarding the company's environmental commitment (Flammer, 2021; Flammer, 2020; Fatica and Panzica, 2021; Yeow and Ng, 2021). The results obtained support the signalling argument, especially when the issuances have certifications attesting to the "greenness" of the bond.

An unexplored issue so far is the role that the board of directors can play in decision-making relating to the issuing of green bonds. On the one hand, previous studies have shown that having a woman on the board of directors increases sensitivity to environmental issues (Galbreath, 2018; García and Herrero, 2020). According to stakeholder theory, having more women on the board improves stakeholder relations, which would improve environmental practices (Hussain et al., 2018). Moreover, some socio-cultural factors are highlighted that may make women more sensitive to sustainability issues, such as their greater education in the humanities (Williams, 2003); their professional career at companies with a greater social and environmental content (Galbreath, 2018); and that they offer different points of view, communication styles and experiences to the male directors and these improve the effectiveness of the board in environmental issues (Liao et al., 2015).

In addition, the existence of a Sustainability Committee reporting to the board of directors implies that the company is not only signalling its environmental commitment, but that the company can be expected to decide on investments aimed at sustainable development, eliminating negative effects, improving environmental performance and reducing risks that may affect the company (Haque, 2017; Hussain et al., 2018).

Therefore, this paper involves two objectives. First, we analyse which corporate sustainability-related corporate factors may have determined the issuance of green bonds globally during the period 2013–2021. Specifically, we focus on three aspects: the percentage of women on the board of directors, the existence of a sustainability committee and the company's environmental performance. Second, we study whether the issuances of green bonds were for greenwashing purposes or, on the contrary, were associated with a greater environmental commitment of the issuing company, taking into account the corporate governance aspects outlined above.

This research makes a number of different contributions to the literature on green bonds. First, we lengthen the time period of the study by several years compared to that seen in the previous empirical literature. This implies the analysis of a larger number of issuances, due to the continuous growth of the green bond market. Flammer (2021) and Fatica and Panzica (2021) agreed that a limitation of their empirical studies was the relatively small number of observations used due to the fact that green bonds were a new financial instrument. These same authors argued that, as more issuances become available, further empirical studies could provide evidence on a larger scale and a more refined conclusion about the long-term implications of these issuances. Second, we analyse whether companies issuing green bonds have certain corporate governance characteristics that could contribute to the use of this green financing instrument, such as a higher percentage of women on the board of directors or the existence of a sustainability committee. Finally, we analyse the environmental implications of green bond issuances by considering five alternative measures of environmental performance. Following Flammer (2020, 2021), we use the Environmental Pillar Score and the volume of CO_2 emissions obtained from the Thomson Reuters Eikon-Refinitiv database. However, we also include the three components of the Environmental Pillar Score, provided by the same database, in order to have robust results. One of those three components is the Environmental Innovation Score. This variable, unlike the previous ones, reflects a company's ability to reduce environmental costs and burdens for its customers, thereby creating new market opportunities through new environmental technologies and processes or ecologically designed products. The second component is the so-called Emission Score. This variable reflects the company's score for its commitment and effectiveness in reducing environmental emissions and waste generation. Finally, the Resource Use Score variable reflects the company's score for its ability to reduce energy and water use and find more eco-efficient solutions.

Our overall results firstly reflect that the companies that issue green bonds, compared to those that issue conventional bonds, obtain a higher environmental score, a lower volume of CO_2 emissions, have a board with a higher percentage of women and have a sustainability committee. These initial findings indicate that they are environmentally and sustainability conscious companies. Moreover, the results obtained in the second part of the research show that these companies continue to perform certain environmentally friendly actions in the years following the issuance. Therefore, these findings contribute to the debate on the motivations and behaviour of companies using this green financing tool.

The paper is structured as follows: In Section 2 we present the literature review and the hypotheses to be studied. In Section 3 we describe the database used. The methodology used in the research is set out in Section 4. In Section 5 we share the empirical results obtained. Finally, Section 6 contains the conclusions from the study, its limitations and future lines of research.

2. Literature review and hypotheses

2.1. Issuances of green bonds and corporate governance characteristics

Any corporate environmental strategy requires the involvement of the board of directors. This relationship can be explained by three complementary theories: agency theory, stakeholder theory and resource dependency theory.

According to agency theory, the board of directors provides the company with advice and supervision that promotes the alignment of interests between the management and the shareholders (Fama and Jensen, 1983; Jensen and Meckling, 1976). The monitoring by the board of directors is fundamental for implementing CSR measures because managers may be reluctant to implement measures that require a great financial effort but bring results in the long term (Berrone and Gomez-Mejia, 2009). Moreover, the corporate board will advise the company about implementing sustainable development (Haniffa and Cooke, 2002), achieving a strong environmental performance (De Villiers et al., 2011) and improving the company's legitimacy (Michelon and Parbonetti, 2012).

Stakeholder theory argues that the company's board of directors defends the interests of all stakeholders (Freeman, 1984). The implementation of environmental strategies goes beyond the creation of shareholder value, and it is necessary to be accountable to the stakeholders and consider the consumers, employees, suppliers, activists, regulators and society as a whole. According to this point of view, the board of directors should improve relationships between the company and its stakeholders and will develop sustainable policies by aligning the long-term goals of managers and stakeholders (Hussain et al., 2018; Michelon and Parbonetti, 2012).

According to resource dependency theory, the board of directors brings human capital to the company, or in other words, its experience, knowledge and skills; along with relational capital, that is, contacts across the sector and with stakeholders (Pfeffer, 1973; Hillman and Dalziel, 2003). All this allows the directors to effectively address environmental issues and adopt appropriate measures (Uyar et al., 2020).

There are two elements of the board of directors that we consider to be particularly relevant in the implementation of the company's environmental strategy: female directors and the existence of a sustainability committee.

In recent decades, the inclusion of women in senior management and leadership positions has highlighted their role in the decision-making process. Some studies have shown that the participation of women on the boards of directors of companies is associated with the publication of more and better information (Armstrong et al., 2014; Gul et al., 2011), greater ethical behaviour by not manipulating information, greater attention to investors (Adams et al., 2011; Matsa and Miller, 2011) and the better supervision of managers (Adams and Ferreira, 2009).

In relation to the development of the corporate environmental strategy, previous studies have shown the greater commitment to environmentally friendly behaviour by boards of directors with gender diversity (Galbreath, 2018; García and Herrero, 2020). First, women are more concerned with improving relations with stakeholders, including society as a whole, thus enhancing environmental and social activities (Hussain et al., 2018). Second, women traditionally have a stronger background in humanities (Williams, 2003); more professional experience in companies with more social and environmental content, resulting in part from gender inequalities (Galbreath, 2018); and, as highlighted by Liao et al. (2015), they bring different points of view and communication styles that enhance the effectiveness of the boards. However, there is no clear consensus on the empirical results and some authors observe a negative relationship between the involvement of women on the board of directors and corporate social responsibility (Handajani et al., 2014), or the need for a minimum number of women to observe socially responsible behaviour (Cucari et al., 2018).

With regard to the sustainability committee, its existence as a committee of the board of directors improves the effectiveness of the company's environmental strategies (Orazalin, 2020). The environmental committee of the board of directors is responsible for planning, organising, implementing and monitoring the corporate sustainability strategy (Liao et al., 2015). According to stakeholder theory, the creation of a sustainability committee confirms the company's commitment to society and to environmental issues (Orazalin, 2020; Biswas et al., 2018; Hussain et al., 2018; Haque, 2017). On an empirical level, most previous studies have confirmed a positive relationship between the existence of a sustainability committee and the company's environmental performance (García and Herrero, 2020; Orazalin, 2020; Mallin and Michelon, 2011). However, some authors like Berrone and Gomez-Mejia (2009) find no relationship between the existence of a sustainability committee and environmental performance.

Based on the arguments presented, we formulate the following hypotheses:

H1. The issuance of green bonds is more likely in companies with a better environmental performance.

H2. The issuance of green bonds is more likely in companies with a higher percentage of female directors.

H3. The issuance of green bonds is more likely in companies that have a sustainability committee.

2.2. Signalling vs greenwashing

The previous literature has provided two very different arguments to explain a company's motivation to issue green bonds: a signalling argument and a greenwashing argument (Flammer, 2020; Flammer, 2021; Fatica and Panzica, 2021; Yeow and Ng, 2021).

According to the signalling theory, with the issuance of green bonds, the company is communicating to investors its intention to make investments aimed at sustainable growth and respect for the environment. The company reduces information asymmetries with investors and communicates its environmental policy aimed at implementing green projects. While there is no single definition of green investment, the term refers to allocating capital to projects with environmental benefits such as: reducing emissions and water and energy consumption, using renewable energy and increasing energy efficiency, sustainable land use, preserving biodiversity, eco-efficient products and climate adaptation (Yeow and Ng, 2021).

However, the need to reduce greenhouse gas emissions and society's concern for and greater awareness of climate change may lead companies to communicate their commitment to the environment for purposes that may be more image-driven than factual. This is known as "greenwashing", which involves appearing to be more sustainable and environmentally friendly than they really are. In the case of financing through green bonds, this would mean the funds raised not ultimately being used for green projects, contrary to what is suggested in the prospectus for the issue.

As stated by Flammer (2021), companies can engage in greenwashing practices in very different ways. Green bond issuances would not, in principle, be the most common greenwashing strategy due to the restrictive purpose of such financing and the associated certification costs. However, analysts, investors and regulators have raised concerns that such practices are behind the notable growth of this financing instrument. This, together with the lack of information about the final use of the funds, makes it necessary to consider this argument.

If the financing obtained with the issuance of green bonds is actually used for its intended purpose, the environmental performance of the company can be expected to improve (Fatica and Panzica, 2021; Flammer, 2021; Benlemlih et al., 2022). According to Flammer (2021), this environmental improvement is not only due to the financing obtained to implement new green projects but is also the consequence of the company actually making a commitment and putting this into practice through the implementation of improvements and in a reduction of the environmental impact of its activity. Moreover, as we document later, the volume of financing obtained through green bonds is still very small. However, in the absence of final impact reports, we have to analyse the indirect impact. Therefore, we cannot expect a causal relationship between the issuance of green bonds and the company's environmental performance, but rather between the issuance of green bonds and other environmentally friendly actions by the company, which will contribute to improving its environmental performance. To actually analyse the real environmental implications of green bond issuances, we must have detailed information on the investment projects for which the bond income is earmarked, as well as their ultimate environmental impacts. However, this information is not normally available.

In this context, the green certification of the issued bonds becomes highly important. However, it should be noted that any guarantees on the proper use of green funds and their certification lie with private entities that measure "greenness" and issue everything from second opinions to green ratings or green bond indices (Nanayakkara and Colombage, 2021). In recent years, alongside the GBP, different regional initiatives have emerged based on these principles and aimed at

increasing the integrity of issuers (Fatica and Panzica, 2021; Cortellini and Panetta, 2021). Thus, it is worth highlighting the launch in 2019 of the European Union's EU Green Bond Standard and in 2020 China's China Green Bond Endorsed Project Catalogue and the ASEAN Green Bond Standards for South Asian countries. Therefore, the improvement in environmental performance is expected to be higher for certified bond issuances as this is a voluntary and costly practice for the issuing company that attests to the appropriate use of the financing in green and environmentally friendly investments (Flammer, 2021; Yeow and Ng, 2021; Fatica and Panzica, 2021).

Based on this, we draw up the following hypotheses:

H4. Companies that issue green bonds improve their environmental performance after the issuance.

H5. Companies that issue certified green bonds improve their environmental performance to a greater extent than those that do not certify the issuances.

3. Database

3.1. Evolution of the green and conventional bonds market

The aim of this study is to analyse global green bond issuances for the period 2013–2019. The database used for this was the Thomson Reuters Eikon-Refinitiv database. From it, we have extracted the total green and conventional bond issuances for the period regardless of country and issuing company. Figs. 1 and 2 show the evolution of transactions performed and localised in terms of both the number of transactions and the volume of funds in US dollars.

As we can see, the importance of green bonds has greatly increased in the bonds market in terms of both the number of transactions (Fig. 1) and the volume of funds (Fig. 2), even though these figures are still much lower than those for conventional bonds.

This growing evolution may be a response to the environmental concerns of the issuing companies, as well as to investor demand for this type of financial product associated with protecting the environment. It is also worth noting the many institutional initiatives in recent years to promote the mobilisation of funds through these financial products. Since the signing of the Paris Agreement and the 2030 Agenda in 2015, numerous initiatives have been launched on a global scale involving both public and private institutions. The main public global initiatives during the years being studied include the works of the G20, with the Green Finance Study Group (GFSG) in 2016 and the Sustainable Finance Study Group (SFSG) in 2018. The latter has been resumed in 2021 to increase the involvement of institutional investors in the financing of sustainable projects (GFSG, 2016; SFSG, 2018). In terms of private sector-led initiatives, the one that stand out most is the United Nations Environment Programme Finance Initiative (UNEP FI), which seeks to mobilise private finance for sustainable development. Also in this area is the Financial Stability Board (FSB), which at the end of 2015 created the Task Force on Climate-Related Financial Disclosures (TCFD). This group is responsible for drawing up voluntary guidelines to help companies disclose information on climate risks and opportunities to their stakeholders in a credible and standardised manner. Finally, at the end of 2019, the European Union, together with financial authorities from Argentina, Canada, Chile, India, Kenya and Morocco, launched the International Platform on Sustainable Finance to mobilise private capital for environmentally sustainable investments (International Platform on Sustainable Finance, 2020).

3.2. Variables

It should be noted that the final sample of companies analysed is made up of those issuing companies for which Thomson Reuters Eikon-Refinitiv has information for the two years before and after the issuance. This requirement is due to the proposed research objectives. The information obtained on green bond issuances has been completed with the database provided by the Luxembourg Stock Exchange, from which we have obtained information on the issuance such as whether it is certified and meets the criteria of the Climate Bond Initiative (CBI), and the purpose of the funds, that is, whether their purpose is to finance new projects, refinance green projects already in existence or both.

We also require information to be available on the following variables being studied:

- The company's environmental performance (EP) estimated through five variables:
  - Environmental Pillar Score (ENV): is the company's weighted average relative rating based on the reported environmental information and results from the aggregation of the scores in its three categories: Emission Score, Resource Use Score and Environmental Innovation Score. The scores range between 0 (worst) and 100 (best).
  - Emission Score (EMI): measures a company's commitment and effectiveness towards reducing environmental emissions and waste generation.
  - Resource Use Score (RES): reflects a company's ability to reduce energy and water use and to find more eco-efficient solutions.

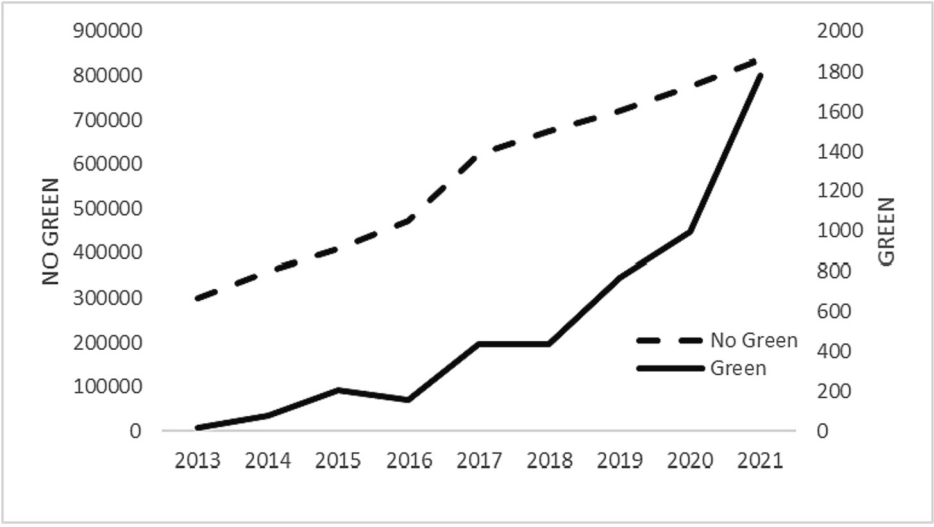

Fig. 1. Number of corporate bonds issued.

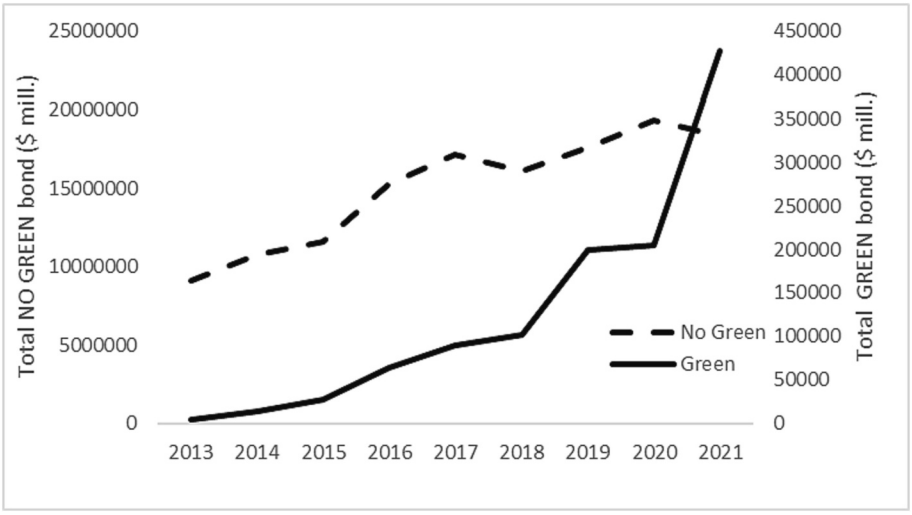

Fig. 2. Volume of corporate bond funds issued.

- Environmental Innovation Score (INN): reflects a company's capacity to create new market opportunities through new environmental technologies and processes, or eco-designed products
- CO_2 emissions relative to total sales (CO_2): total CO_2 and CO_2-equivalent emissions in tonnes divided by total sales

- Women directors (WOM): women directors on the corporate board as a proportion of the total number of directors
- Sustainability committee (COM): dummy variable that takes 1, if the firm has a sustainability committee; 0, otherwise
- Firm size (ACT): The natural logarithm of total assets
- Profitability (ROA): Return on assets
- Leverage (LEV): Total debt to total assets

The variables used to alternatively measure the company's environmental performance (EP), as well as the dummy variable indicating whether or not the issuing company has a sustainability committee and the percentage of female directors, provide us with information directly or indirectly on how the company behaves in relation to the environment. In contrast, the size, ROA and leverage variables are control variables.

It should also be noted that there are companies that issue several green bonds during the period being studied. In this case, we select the first issuance of green bonds and discard subsequent issuances from the study in order to analyse the impact of the first issue and avoid overlaps.

These limitations substantially reduce the number of transactions available for analysis. Table 1 reflects the screening process. Thus, with respect to the green bond issuances performed by public and private firms during the period 2013 to 2021 (4781 transactions made by 1721 companies according to the Thomson Reuters Eikon-Refinitiv database), we select the 2904 for which we have information in the Luxembourg Stock Exchange database. Given the time horizon of the study, from these we selected the 1112 issuances made in the period from 2013 to 2019. After selecting only, the first issuances and eliminating those for which the required information is not available, the number of green bond issuances that make up the final sample is 201.

Table 1
Screening process of issuances and firms.

	Public issuances (firms)	Private issuances (firms)	All issuances (firms)
Thomson 2013–2021	2662 (946)	2119 (775)	4781 (1721)
Thomson 2013–2021 &Luxembourg	1389 (462)	1515 (591)	2904 (1053)
Thomson 2013–2019 & Luxembourg	404 (205)	708 (274)	1112 (479)
Thomson 2013–2019 & Luxembourg & data	399 (201)		399 (201)
Thomson 2013–2019 & Luxembourg & data & first issuance	201 (201)		201 (201)

Note: Green bond issuances performed by public and private firms for the time horizon of the study, for which the required information is available and after selecting only the first issuance.

With regard to companies issuing conventional bonds, we selected the first issuance of bonds made by a company that, during the 2013 to 2019 period, had not issued any green bonds, belonged to a sector of activity and country represented in the sample of green bond issuances and also had information on the aforementioned variables. All these requirements limited the study to a total of 4786 issuances.

In Table 2 we can see the distribution by year, country, and sector of the number of green and conventional issuances in the sample, as well as the aggregate data. As can be observed, the country with the highest number of green issuances is Japan, followed by China, Sweden, France, and the United States. These six countries account for 55 % of the green issuances under study. Specifically, Japan accounts for 14 % of the issuances, China for 10 %, Sweden for 7 %, France for 6 % and the United States for 5 %. Meanwhile, the analysis by sector shows that the financial sector dominates, followed by Real Estate, Utilities and Industrials. Specifically, 36 % of the green issuances correspond to financial companies, 22 % to Real Estate companies, 16 % to Utilities and 12 % to industrials.

Table 3 shows the descriptive statistics of the variables used and the correlation matrix. To mitigate the impact of outliers, all ratios are winsorized at the 1st and 99th percentiles of their empirical distribution.

4. Methodology

As indicated above, this research has two objectives. Firstly, we analyse whether, in the two years prior to the issuance, companies issuing green bonds are characterised by their relationship with their environment, the participation of women on the board of directors and the existence of a sustainability committee. Secondly, we examine whether these companies have a better environmental performance post-issuance than pre-issuance. We also study whether there are significant differences with respect to companies that issue conventional bonds and never issue green bonds.

Firstly, we compare the characteristics of the companies that issue green bonds with those that issue conventional bonds. To do this, we

Table 2
Distribution of green and non-green bond issues by year, country and industry.

Year							Country - Total issues	Industry									
2013	2014	2015	2016	2017	2018	2019		1	2	3	4	5	6	7	8	9	10
0(0)	1(28)	0(11)	1(1)	1(8)	0(5)	1(4)	**Australia -** 4(57)	0(5)	0(9)	0(2)	0(0)	1(5)	3(24)	0(0)	0(0)	0(1)	0(11)
0(0)	1(4)	0(4)	0(2)	1(0)	1(2)	0(1)	**Austria** - 3(13)	0(2)	0(2)	0(1)	0(1)	0(0)	2(3)	0(0)	0(0)	1(0)	0(4)
0(3)	0(12)	0(2)	1(3)	0(1)	1(7)	0(4)	**Belgium** - 2(32)	0(2)	0(3)	0(2)	0(2)	0(3)	1(5)	0(0)	0(0)	0(0)	1(15)
0(3)	0(14)	1(12)	0(5)	0(3)	0(16)	0(28)	**Brazil** - 1(81)	0(6)	0(9)	0(21)	0(4)	1(13)	0(3)	0(0)	0(1)	0(8)	0(16)
0(8)	0(43)	0(36)	0(21)	1(29)	0(32)	4(17)	**Canada** - 5(186)	0(47)	0(22)	0(3)	0(6)	0(7)	5(54)	0(0)	0(14)	0(9)	0(23)
0(0)	0(5)	0(3)	0(2)	0(1)	1(4)	2(2)	**Chile** - 3(17)	0(2)	0(4)	0(0)	0(3)	0(4)	1(1)	0(0)	0(1)	2(1)	0(1)
0(0)	0(10)	1(14)	3(21)	3(5)	7(78)	7(36)	**China** - 21(164)	1(7)	0(22)	2(3)	1(11)	0(6)	12(60)	0(0)	0(36)	4(0)	1(19)
0(0)	0(1)	1(2)	0(0)	1(1)	0(1)	1(0)	**Denmark** - 3(5)	1(0)	0(0)	0(0)	0(0)	0(0)	1(4)	0(1)	0(0)	1(0)	0(0)
0(4)	0(5)	0(4)	0(2)	1(2)	0(2)	2(3)	**Finland** - 3(22)	0(1)	1(5)	0(6)	0(1)	0(1)	1(4)	0(0)	0(0)	0(0)	1(4)
2(10)	2(46)	1(11)	3(15)	1(6)	1(6)	4(6)	**France** - 14(100)	0(3)	0(7)	2(23)	0(21)	0(6)	5(8)	0(4)	0(2)	2(3)	5(23)
0(7)	0(26)	0(16)	0(13)	1(6)	4(18)	3(11)	**Germany** - 8(97)	0(3)	0(13)	1(15)	0(18)	1(7)	4(15)	0(3)	0(2)	2(2)	0(19)
0(3)	0(9)	0(3)	1(6)	1(8)	1(3)	1(5)	**Hong Kong** - 4(37)	0(1)	0(3)	1(5)	0(0)	0(4)	0(4)	0(0)	0(3)	1(6)	2(11)
0(13)	0(41)	0(31)	1(122)	1(54)	0(59)	1(20)	**India** - 3(340)	0(7)	0(75)	0(60)	0(51)	0(24)	2(77)	0(2)	0(1)	1(11)	0(31)
0(12)	2(12)	0(8)	0(3)	2(4)	1(2)	5(3)	**Italy** - 10(44)	1(5)	0(1)	0(9)	0(2)	0(2)	2(18)	0(0)	0(0)	7(5)	0(2)
0(61)	0(152)	0(73)	2(131)	3(149)	18(128)	25(60)	**Japan** - 48(754)	0(8)	2(77)	13(207)	1(141)	0(79)	13(65)	0(0)	1(74)	0(5)	18(98)
0(85)	0(62)	0(59)	0(182)	0(119)	1(185)	2(157)	**S. Korea** - 3(849)	0(20)	1(106)	0(168)	0(130)	0(85)	0(60)	0(4)	1(263)	1(7)	0(6)
0(1)	0(5)	0(5)	0(2)	0(2)	0(2)	2(2)	**Luxembourg** - 2(19)	0(1)	0(2)	0(0)	0(0)	0(1)	0(4)	0(0)	1(3)	0(0)	1(8)
0(2)	0(10)	0(4)	0(4)	1(4)	1(2)	0(5)	**Mexico** - 2(31)	0(0)	0(6)	0(2)	1(6)	0(12)	0(0)	0(0)	0(1)	0(0)	1(4)
0(4)	0(6)	0(5)	1(3)	0(2)	1(3)	2(2)	**Netherlands** - 4(25)	0(2)	0(3)	1(2)	0(1)	0(2)	2(5)	1(0)	0(6)	0(0)	0(4)
0(1)	0(3)	0(0)	0(1)	1(1)	0(3)	1(0)	**N. Zealand** - 2(9)	0(2)	0(0)	0(0)	0(1)	0(1)	0(0)	0(0)	0(0)	1(1)	1(4)
0(0)	0(0)	0(0)	0(0)	0(0)	0(1)	1(0)	**Nigeria** - 1(1)	0(1)	0(0)	0(0)	0(0)	0(0)	1(0)	0(0)	0(0)	0(0)	0(0)
0(0)	0(5)	0(36)	1(0)	1(4)	0(7)	2(2)	**Norway** - 4(54)	0(11)	0(5)	0(0)	0(0)	0(2)	2(33)	0(0)	0(0)	1(0)	1(3)
0(0)	0(4)	0(2)	0(1)	0(1)	0(1)	1(7)	**Philippines** - 1(16)	0(1)	0(0)	0(1)	0(0)	0(3)	1(9)	0(0)	0(0)	0(0)	0(2)
0(0)	0(0)	0(3)	0(1)	0(0)	0(1)	1(1)	**Portugal** - 1(6)	0(1)	0(1)	0(0)	0(1)	0(0)	0(1)	0(0)	0(0)	1(2)	0(0)
0(3)	0(20)	0(6)	0(5)	1(7)	0(2)	0(4)	**Singapore** - 1(47)	0(9)	0(1)	0(0)	0(1)	0(4)	1(3)	0(0)	0(0)	0(0)	0(29)
0(0)	0(15)	0(3)	0(2)	0(0)	1(3)	0(3)	**S. Africa** - 1(26)	0(0)	0(5)	0(0)	0(4)	0(4)	0(3)	0(0)	0(0)	0(0)	1(10)
0(3)	0(2)	0(11)	0(5)	1(6)	1(5)	2(5)	**Spain** - 4(37)	1(2)	1(5)	0(7)	0(3)	0(0)	2(5)	0(0)	0(5)	0(3)	0(7)
0(4)	0(21)	0(12)	1(16)	4(20)	3(22)	8(26)	**Sweden** - 16(121)	1(3)	0(8)	2(24)	1(22)	0(8)	3(16)	0(0)	0(11)	1(0)	8(29)
0(0)	0(12)	0(12)	0(5)	0(3)	0(5)	3(4)	**Switzerland** - 3(41)	0(1)	0(6)	0(3)	0(2)	0(3)	1(8)	0(3)	0(5)	1(0)	1(10)
0(29)	0(50)	0(39)	0(47)	0(49)	1(46)	0(41)	**Taiwan** - 1(301)	0(0)	1(34)	0(68)	0(16)	0(7)	0(25)	0(0)	0(122)	0(0)	0(29)
0(5)	0(27)	0(24)	0(16)	0(13)	0(19)	2(6)	**Thailand** - 2(110)	0(9)	0(6)	1(20)	0(10)	0(8)	0(0)	0(0)	0(0)	1(15)	0(42)
0(2)	0(4)	0(6)	0(3)	0(0)	0(3)	2(18)	**Turkey** - 2(36)	0(1)	0(3)	0(0)	0(7)	0(1)	2(20)	0(0)	0(0)	0(0)	0(4)
0(0)	0(2)	0(0)	0(0)	1(3)	0(0)	0(0)	**UA Emirates** - 1(5)	0(1)	0(0)	0(0)	0(0)	0(0)	1(2)	0(0)	0(0)	0(0)	0(2)
0(5)	0(19)	1(43)	0(13)	2(30)	1(10)	1(10)	**UK** - 5(130)	0(10)	0(8)	1(16)	0(13)	0(15)	2(41)	0(2)	1(5)	1(7)	0(13)
0(52)	0(146)	0(293)	2(151)	1(71)	2(70)	8(190)	**USA** - 13(973)	0(105)	0(26)	0(42)	1(87)	1(40)	3(364)	0(63)	2(77)	3(37)	3(131)
2(320)	6(821)	5(793)	17(804)	30(612)	47(753)	94(683)	**201(4786)**	5(279)	6(477)	24(710)	5(565)	4(357)	73(944)	1(82)	6(632)	32(123)	45(614)

Notes: Non-green bond issues are reported in parentheses. Industry codes are (1) Energy, (2) Basic Materials, (3) Industrials, (4) Consumer Cyclicals, (5) Consumer Non-Cyclicals, (6) Financials, (7) Healthcare, (8) Technology, (9) Utilities and (10) Real Estate.

Table 3
Correlation matrix and descriptive statistics.

	ENV	COM	WOM	ACT	LEV	ROA	CO2	EMI	RES	INN
COM	0.268									
WOM	0.221	0.106								
ACT	0.433	0.167	0.193							
LEV	−0.120	−0.066	−0.005	−0.230						
ROA	−0.050	0.013	0.018	−0.157	−0.085					
CO2	−0.114	−0.075	−0.045	−0.047	0.036	−0.010				
EMI	0.713	0.280	0.140	0.331	−0.099	−0.023	−0.103			
RES	0.718	0.284	0.282	0.309	−0.108	0.040	−0.100	0.522		
INN	0.655	0.127	0.051	0.335	−0.135	−0.077	−0.080	0.250	0.226	
Obs	8,500	8,396	8,443	8,495	8,495	8,458	5,412	8,500	8,500	8,488
Mean	46.340	0.628	0.173	10.085	0.302	0.026	428.820	49.738	48.187	34.377
Std. dev.	30.908	0.483	0.137	0.792	0.184	0.068	1,886.069	34.767	34.821	34.029
Min	0.000	0.000	0.000	7.097	0.001	−0.352	0.000	0.000	0.000	0.000
Max	98.889	1.000	0.750	12.620	0.840	0.210	67,094.520	99.890	99.901	99.774

perform a univariate test of the difference between means of the variables analysed, comparing green and non-green bond issuances and the period before and after the issuance.

Next, to explore the association between the firm's environmental characteristics and the launch of a green bond issue, we study the propensity of the firm to initiate a green bond issue.

We modelled the propensity to issue a green bond as a function of environmental characteristics. Specifically, we used a logit model to estimate the likelihood of issuing a green bond, as shown in Eq. (1).

$$Log\left(\frac{\pi(x_{it})}{1-\pi(x_{it})}\right) = \beta_0 + \beta_1 EP_{it} + \beta_2 WOM_{it} + \beta_3 COM_{it} + \beta_4 ACT_{it} + \beta_6 ROA_{it} + \beta_7\ LEV_{it} \quad (1)$$

where $\pi(x_{it})$ is the probability that firm i made a green bond issuance in year t, and $\frac{\pi(x_{it})}{1-\pi(x_{it})}$ is the odds ratio. We perform the model for the two years prior to the issue. We control for firm size, performance and indebtedness. We also control for country, year and industry fixed effects. Finally, we calculate robust standard errors.

The second objective of this research is to study whether raising funds through the issuance of green bonds leads to better environmental performance by firms.

To examine how the environmental variables analysed at the firm level evolve after the issuance of green bonds, we first estimate a difference-in-difference specification using the information available in the two years before and the two years after the issuance, for both green bond issuing firms and conventional bond issuing firms.

Specifically, we estimate the regression shown in Eq. (2).

$$EP_{it} = \beta_0 + \beta_1 GREEN_{it} + \beta_2 POST_{it} + \beta_3 POST_{it}xGREEN_{it} + \beta_4\ WOM_{it} + \beta_5 COM_{it} + + \beta_6 ACT_{it} + \beta_7 ROA_{it} + \beta_8 LEV_{it} \quad (2)$$

where GREEN is a dummy variable that takes 1 if the firm issues a green bond and 0 otherwise and POST is a dummy variable that takes 1 for the two years following the bond issue and 0 otherwise. The interaction term POST × GREEN indicates the two years following the green bond issuance. The subindex i indexes firms and t indexes years. The rest of the variables are defined in Section 3. We also control for country, year and industry fixed effects. Finally, we calculate robust standard errors.

We then focus on companies issuing green bonds to analyse their behaviour around the issuance. To address any possible endogeneity problems (Sattar et al., 2021; Zalata et al., 2022) and potential sample selection bias, and to therefore obtain unbiased estimates, we have applied the methodology of Heckman (1979). The two-step process proposed by Heckman (1979) allows us to isolate the sample selection bias arising from the self-selection of the firms that decide to issue green bonds. If this bias is not taken into account, the estimates could be biased by the fact that green bond issuers are a segment of the total number of firms that decided to finance themselves through a bond issue. To address this problem, Heckman proposes a two-step process.

In the first step, we modelled the propensity to issue green bonds as a function of a firm's environmental characteristics. Specifically, we used a probit model to estimate the likelihood of a green bond issue, Eq. (3). From this estimation we obtain the inverse of the Mills ratio (IMR) that captures the endogeneity bias. In the second step, the cross-sectional environmental performance of green bond issuers equation was estimated using environmental performance as a dependent variable by including the inverse of the Mills ratio (IMR) obtained from the choice equation in the first step. The coefficient for IMR in the environmental Eq. (4) captured the effects of unobserved variables on environmental performance and its statistical significance shows the magnitude of bias that would have been present if it had not been incorporated into the regression. According to Li and Prabhala (2007), correcting for self-selection helps prevent biased estimators, as well as including and controlling for unobservable private information that influences corporate finance decisions.

First step:

$$Pr(GREEN = 1) = \beta_0 + \beta_1 EP_{it} + \beta_2 WOM_{it} + \beta_3 COM_{it} + \beta_4 ACT_{it} + \beta_6 ROA_{it} + \beta_7 LEV_{it} \quad (3)$$

Second step:

$$EP_{it} = \beta_0 + \beta_1 POST_{it} + \beta_2 CBI_{it} + \beta_3 POST_{it}xCBI_{it} + \beta_4\ FIN_{it} + \beta_5 POST_{it}xFIN + \beta_6 IMR_{it} \quad (4)$$

The dependent variable was environmental performance (EP), approximated by the five variables defined above: ENV, EMI, RES, INN and CO_2. The independent variables were POST (defined above) and two variables related with the issue that previous evidence has shown to be related to the environmental performance of green bond issuers. The first variable is the certification of the issue by an independent organisation. External certification by independent organisations reduces asymmetries between issuers and investors at the cost of issuers in order to ensure compliance with specific criteria (Fatica and Panzica, 2021). Certified green bonds also signal the company's commitment to the environment in a more credible way (Flammer, 2021). The second variable is related to the purpose of the funds. The use of proceeds for financing or refinancing purposes may be relevant for analysing the real impact of green bond issues on environmental performance (Fatica and Panzica, 2021). Financing green bonds represent new green projects financed and thus an increase in climate-friendly activities. However, refinancing green bonds are issued to refinance existing green projects and therefore do not represent an increase in sustainable activities.

Specifically, we included the following variables:

- Certificate (CBI): dummy variable that takes 1 for bonds with external certification under the Climate Bond Initiative (CBI) and 0 otherwise. Among all the certifications we chose the one obtained from the CBI as most issues are certified by ICMA, which would not differentiate between certified and non-certified bonds.
- Financing (FIN): dummy variable that takes 1 for green bonds issued for financing purposes and 0 otherwise

We run the model for the two years following the issue. We control for country, year and industry fixed effects. We calculate robust standard errors.

5. Results

With regard to the comparison between companies issuing green bonds and those issuing conventional bonds, Table 4 presents the mean values for the entire sample of bonds (green and conventional), differentiating the period before and after the issuance, as well as the *p*-value of the difference in means test.

If we compare green and non-green bond issuances in the pre-issuance period (Panel A), we can observe significant positive differences in the means for the variables that measure the company's relationship with the environment through the scores, and significant negative differences in the case of CO_2 emissions. This suggests that companies issuing green bonds have a better environmental performance. They are also companies with a higher percentage of female directors, a sustainability committee and they are larger in size.

Moreover, as can be seen in Panel B, for green companies this relationship is improved after the issuance of green bonds in terms of the score for volume of emissions and resource use. In contrast, companies issuing conventional bonds show completely different behaviour as we observe a statistically significant decrease in the mean values of the environmental variables post-issuance.

With regard to the determinants of the probability of issuing green bonds, Table 5 shows the results for each of the variables used as estimators of environmental performance.

The results confirm that the issuance of green bonds is more likely to occur through companies with a higher environmental score, a sustainability committee and that are larger in size. These results are in line with the previous empirical evidence. However, gender diversity does not in any way explain the issuance of green bonds by companies.

If we focus on the three components of the environmental score (EMI, RES, INN), we can say that the aforementioned result holds except for the variable measuring resource use. In other words, it seems that companies that are more likely to issue green bonds are those with a higher environmental innovation score and greater control of emissions. Finally, with regard to the level of CO_2 emissions, it is confirmed that companies with a lower level of CO_2 emissions are more likely to issue green bonds. Therefore, we can say that the results obtained confirm Hypotheses 1 and 3 and do not support Hypothesis 2. Moreover, these overall results suggest that companies that issue green bonds are mostly companies that are aware of corporate social responsibility concerns and perform actions to care for the environment.

Table 6 shows the impact of issuing green bonds and their impact over time (two years after the issuance) on the variables estimating environmental performance.

The *GREEN* variable shows that green bond issuers have more environmentally friendly behaviour. However, the variable of interest, POST × GREEN, is not significant in any case (although the signs are as expected). In short, green bond issuers are more environmentally friendly although they are not greener after the issue, in other words, they continue to perform in the same way as they have been doing. With regard to the other variables, it seems that the involvement of women on the board of directors and the existence of a sustainability committee enhances the green performance of companies.

As in the previous analysis, the results are similar for the two

Table 4
Difference in means of green and conventional bond issuances.

	Green	Non-green	
Panel A: difference green-non green			
Pre issue			Difference (p-value)
ENV	65.561	46.691	18.870 (0.000)
EMI	67.793	49.511	18.282 (0.000)
RES	65.815	48.357	17.458 (0.000)
INN	57.766	33.213	24.553 (0.000)
CO2	230.322	401.828	−171.506 (0.023)
WOM	0.218	0.147	0.072 (0.000)
COM	0.869	0.646	0.222 (0.000)
ACT	10.712	10.095	0.617 (0.000)
LEV	0.293	0.288	0.004 (0.701)
ROA	0.027	0.031	−0.004 (0.316)
Post issue			
ENV	68.620	43.162	25.458 (0.000)
EMI	73.662	47.043	26.619 (0.000)
RES	70.471	45.323	25.148 (0.000)
INN	61.715	31.718	29.998 (0.000)
CO2	171.747	493.140	−321.394 (0.034)
WOM	0.262	0.184	0.079 (0.000)
COM	0.874	0.584	0.290 (0.000)
ACT	10.705	9.985	0.719 (0.000)
LEV	0.317	0.310	0.006 (0.611)
ROA	0.025	0.022	0.002 (0.595)

Panel B: difference pre issue-post issue		
	Difference (p-value)	Difference (p-value)
ENV	−3.059 (0.181)	3.529 (0.000)
EMI	−5.869 (0.008)	2.468 (0.003)
RES	−4.656 (0.055)	3.035 (0.000)
INN	−3.950 (0.142)	1.495 (0.047)
CO2	58.575 (0.384)	−91.313 (0.154)
WOM	−0.044 (0.001)	−0.037 (0.000)
COM	−0.005 (0.786)	0.063 (0.000)
ACT	0.008 (0.941)	0.110 (0.000)
LEV	−0.024 (0.112)	−0.022 (0.000)
ROA	0.002 (0.605)	0.009 (0.000)

Table 5
Characteristics of companies issuing green bonds.

Logit model regressions					
ENV	0.0114				
	(0.026)				
EMI		0.0089			
		(0.021)			
RES			0.0024		
			(0.573)		
INN				0.0101	
				(0.003)	
CO2					−0.0004
					(0.002)
WOM	−0.9828	−0.9439	−0.9119	−0.9283	−0.3592
	(0.365)	(0.383)	(0.395)	(0.393)	(0.786)
COM	0.9643	1.0123	1.2257	1.0805	1.5478
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
ACT	1.8568	1.9175	1.9909	1.8605	1.8988
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
LEV	0.3631	0.3503	0.4827	0.7101	−1.089
	(0.883)	(0.886)	(0.843)	(0.775)	(0.679)
ROA	1.8266	1.864	1.7799	1.8648	0.5785
	(0.003)	(0.003)	(0.005)	(0.003)	(0.439)
Intercept	−24.4589	−25.0945	−25.5614	−24.0625	−23.8438
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
Obs.	2,853	2,853	2,853	2,853	1,894
Pseudo R2	0.4882	0.4879	0.4857	0.4901	0.4611
Country	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors were estimated controlling for country, year and industry fixed effects. The p-value for each coefficient is reported in parentheses.

Table 6
Difference-in-difference regressions.

	Environmental performance (EP)				
	ENV	EMI	RES	INN	CO2
GREEN	3.507	2.097	1.404	9.093	−211.044
	(0.000)	(0.063)	(0.217)	(0.000)	(0.003)
POST	0.294	0.117	−0.545	1.177	5.284
	(0.583)	(0.849)	(0.378)	(0.117)	(0.938)
POST × GREEN	0.252	0.732	0.524	0.200	−99.102
	(0.860)	(0.637)	(0.753)	(0.925)	(0.358)
WOM	13.489	9.393	12.227	9.353	−786.100
	(0.000)	(0.000)	(0.000)	(0.003)	(0.071)
COM	27.171	31.900	31.337	19.215	−319.512
	(0.000)	(0.000)	(0.000)	(0.000)	(0.019)
ACT	16.085	16.418	17.473	14.234	89.297
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)
ROA	3.687	9.952	12.267	−25.741	−910.142
	(0.218)	(0.004)	(0.001)	(0.000)	(0.001)
LEV	−7.757	−8.236	−8.791	−10.038	−382.872
	(0.000)	(0.000)	(0.000)	(0.000)	(0.181)
Intercept	−127.912	−122.889	−134.638	−139.668	65.325
	(0.000)	(0.000)	(0.000)	(0.000)	(0.834)
Obs	8,300	8,300	8,300	8,288	5,330
R2	0.6338	0.6165	0.6090	0.3836	0.1819
Country	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors were estimated controlling for country, year and industry fixed effects. The *p*-value for each coefficient is reported in parentheses.

components of the environmental score, namely for environmental emissions and innovation, as well as for the volume of CO_2 emitted in relation to their level of sales, reflecting the commitment green bond issuers have to the environment. However, the results are not significant for the resource use variable. In addition, in no case do we detect significant behaviour by green bond issuers in the two years following the issuance.

With regard to the role of issuance certification and the purpose of the funds in the environmental performance of companies issuing green bonds, Table 7 presents the results obtained for the different environmental performance variables. Three models have been estimated for each of these; one analysing the influence of CBI certification (CBI and POST × CBI variables), another analysing the role of the purpose of the funds obtained (FIN and POST × FIN variables) and a third including all variables. Before commenting on the results, we should point out that in this case we are only looking at green bond issuers, which could lead to a selection bias problem. Therefore, we apply the technique described by Heckman (1979) and as can be observed in Table 7, the significant value of the IMR variable highlights the need for the methodology applied.

With regard to the performance of companies issuing green bonds after the issuance, the results in Table 7 show that companies improve their environmental pillar score (ENV), emission score (EMI) and environmental innovation score (INN). This result leads to a partial acceptance of Hypothesis 4, since for the resource use score (RES) and CO_2 emissions (CO2) score, the results, although consistent in signs, are not significant. In general, these results are positive and in line with those obtained previously. Companies that issue green bonds continue to perform certain environmentally friendly actions in a post-issue period.

With regard to the certification of bonds, we should point out that the sign and significance of the CBI variable shows that it is the companies with a worse environmental score (ENV) that certify emissions. Similarly, as can be seen in Table 7, Hypothesis 5 is rejected because the results of the interaction between the CBI and POST variables does not show that this certification subsequently leads to a different environmental performance to that observed for the set of green issuers. This lack of a subsequent significant performance for the companies that certify their bond issuances and the fact that these companies have a worse environmental score prior to the issuance leads us to wonder whether the purpose of the certification is to signal their green performance. One possible explanation could be related to the cost that companies must incur when they decide to certify a green bond issuance. It is possible that only those companies interested in sending a signal to their stakeholders about their green behaviour would wish to bear this cost.

Finally, a result that we believe is interesting to mention is that the attraction of new green funds is positively and significantly related to the environmental innovation score (INN), that is, the company's ability to create new market opportunities through environmental innovation. However, we do not find any significant performance in the post-issuance period. One possible explanation could be that these bonds are intended to finance infrastructure projects. In that case, their environmental impact may not occur in the two-year period after issuance, instead taking longer to produce significant effects.

6. Conclusions

Numerous investments and, to fund them, large amounts of money are needed to contribute to the fight against climate change and the transition towards a low-carbon economy. As a result, the green bonds market has experienced extraordinary growth worldwide in recent years, although it has not yet reached the volumes for conventional issuances.

Similarly, empirical studies are emerging in the academic literature that analyse the characteristics of companies using this green finance tool, along with others that focus on examining the environmental commitment of these companies in the years following the issuance. However, previous studies have not provided conclusive results. This is partly because they use a small sample of green issuances and partly because they do not take into account certain aspects of corporate governance that could shed more light on the issue being studied.

In this context, this study contributes to the previous literature in several respects. First, it analyses a wider sample of green issuances due to the growth in the market in recent years. Second, we take into account the fact that the corporate environmental strategy requires the involvement of the board of directors and, therefore, the characteristics

Table 7
Environmental performance following the issuance of green bonds.

	Environmental performance (EP)														
		ENV			EMI			RES			INN			CO2	
POST	3.428	4.071	4.169	5.048	4.615	6.071	1.698	1.808	1.535	5.117	5.233	4.808	−53.160	−47.310	−52.835
	(0.078)	(0.036)	(0.045)	(0.008)	(0.019)	(0.003)	(0.409)	(0.432)	(0.512)	(0.077)	(0.062)	(0.100)	(0.390)	(0.480)	(0.481)
CBI	−3.656		−3.581	−8.863		−11.012	−7.276		−6.038	−1.870		1.591	3.054		−11.535
	(0.074)		(0.097)	(0.000)		(0.000)	(0.044)		(0.132)	(0.523)		(0.582)	(0.933)		(0.765)
POST × CBI	2.253		1.034	−0.292		−1.897	4.942		3.669	2.808		1.217	31.859		28.727
	(0.385)		(0.688)	(0.919)		(0.479)	(0.172)		(0.353)	(0.486)		(0.761)	(0.611)		(0.668)
FIN		3.550	3.134		−1.210	−2.886		0.125	−0.425		12.372	12.688		21.151	21.981
		(0.140)	(0.196)		(0.707)	(0.374)		(0.968)	(0.892)		(0.002)	(0.002)		(0.624)	(0.613)
POST × FIN		0.998	0.877		2.742	2.400		3.330	3.117		−3.372	−3.327		49.774	48.165
		(0.721)	(0.757)		(0.372)	(0.437)		(0.383)	(0.417)		(0.488)	(0.491)		(0.475)	(0.483)
Intercept	141.774	144.151	147.933	135.808	141.940	155.687	163.178	156.311	161.884	73.630	60.377	57.951	766.150	880.822	881.276
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.001)	(0.004)	(0.000)	(0.000)	(0.000)
IMR	−30.142	−33.219	−33.336	−22.930	−24.420	−24.756	−35.563	−37.488	−37.694	−25.250	−28.408	−28.363	−176.933	−196.712	−197.267
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.044)	(0.033)	(0.036)
Obs	646	595	595	646	595	595	646	595	595	646	595	595	564	520	520
R2	0.6445	0.6759	0.6772	0.5952	0.6058	0.6225	0.6401	0.612	0.6146	0.4936	0.5336	0.5341	0.3685	0.3694	0.3695
Country	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes

Notes: Standard errors were estimated controlling for country, year and industry fixed effects. The p-value for each coefficient is reported in parentheses.

of the board are likely to play a relevant role in the company's green bond issuance decisions. We therefore consider the role of the board of directors in the analysis of the previous characteristics of companies issuing green bonds, as well as in the analysis of the environmental implications of this issuance. Finally, unlike previous studies, we use up to five variables to represent the environmental performance of companies in order to present robust results.

The finding of some improvement in environmental performance after the issuance of green bonds warrants some discussion. First, companies with a higher environmental score, lower CO_2 emissions and a sustainability committee are more likely to issue green bonds. Also, compared to conventional bond issuers, companies that use green finance are characterised by a higher environmental score, lower volume of CO_2 emissions, a board with a higher percentage of women and a sustainability committee. The results are consistent with previous findings (Fatica and Panzica, 2021; Flammer, 2021).

However, firms do not improve their environmental performance following the issuance of green bonds, even in the case of issues intended to finance new green projects. This result is consistent with Yeow and Ng (2021) but contrary to Fatica and Panzica (2021) and Flammer (2021) and Benlemlih et al. (2022).

In the case of externally certified emissions, they seem to be used by companies with poorer environmental scores in order to improve their image.

This result is consistent with the greenwashing argument, as green bonds do not have a real beneficial impact on the environment. However, the fact that green bond issuers have higher environmental scores and a lower volume of CO_2 emissions in the two years previous to issuance indicate that they are environmentally conscious companies with sustainable and climate-friendly projects.

The market for corporate green bonds is at an early stage and future investigation is needed. This is particularly true for the period following the issuance of green bonds. One possible explanation of our results could be related to the selection of a 2-year window for the post-issue performance analysis. As indicated previously, this could be relatively short if bonds are intended to finance infrastructure projects, since in this case their full impact may not be seen within the window. For these reasons, future research should be focused on extending the study window and analysing the longer-term behaviour of the issuing companies. Moreover, aspects such as the purpose of green bonds and the confidence that the funds obtained are actually used to finance sustainable projects should be studied in greater depth. In fact, one of the limitations of our study is the reduction in the sample observed when incorporating these aspects into the study.

Likewise, in the coming years, progress is expected to be made in the global standardisation of green financial products, as well as in the transparency of corporate information on their contribution to sustainable development and combatting climate change. This will provide new scenarios for the empirical analysis of green financial instruments.

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

Data availability

Data will be made available on request.

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C. José García is Graduated and obtained his PhD in Economics and Business from the Universitat de València, where he is currently a Professor in Finance. He is also a Director at the Cátedra Finanzas Internacionales Banco Santander Universitat de València. The results of the research have been published in national and international journals with significant impact also working as an organizer and evaluator in different journals and national or international conferences.

Begoña Herrero obtained a PhD in Economics from the University of València and an Associate Professor at the Department of Corporate Finance at the University of València. She has developed her research in themes related with price efficiency and the arrival of new information to financial markets. Her areas of research interest are corporate boards and corporate acquisitions, subjects on which he has supervised several doctoral theses and has published numerous articles in national and international journals. She has authored several articles in peer-reviewed high impact journals.

José Luis Miralles-Quirós is an Associate Professor of Financial Economics and Accounting at the University of Extremadura in Spain. His research has primarily focused on providing shareholders' investment strategies that would beat the market in adverse situations using sophisticated mathematical approaches. Meanwhile, his research also includes the analysis of companies' environmental, social, and corporate governance

activities and their connection to shareholders' value creation. These works have been published in prestigious journals.

Maria del Mar Miralles-Quirós is an Associate Professor of Financial Economics and Accounting and the Director of the Research Group on Markets and Financial Assets at the University of Extremadura in Spain. Her research has focused on providing shareholders' investment strategies that would beat the market using sophisticated mathematical approaches, as well as the analysis of companies' sustainable activities and their connection to shareholders' value creation. Her research works have been published in prestigious journals.