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ESG incidents and corporate green bond market reaction

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A B S T R A C T

This paper examines how the secondary market for corporate green bonds reacts to the announcement of Environmental, Social and Governance (ESG) incidents. We compare the cumulative abnormal returns (CARs) of green bonds with those of similar conventional bonds issued by the same firm, using a large international sample covering the period 2013–2022. Our results indicate that the performance of both green and conventional bonds declines after an ESG incident, but the decline is more pronounced for conventional bonds. We attribute this finding to the cost-effectiveness motive driving investors' response to the ESG incident, as we find that a) there is no green premium (at issuance) in our sample, and b) green bonds are, on average, less liquid than conventional bonds, making the latter easier to sell due to lower transaction costs. Consistent with this argument, we observe opposite findings – namely, no significant performance differences and conventional bonds outperforming green bonds after the ESG incident – only in cases where green bonds exhibit higher liquidity, such as those issued by European firms or those compliant with the Climate Bond Initiative (CBI) standards.

1. Introduction

Green bonds have attracted the interest of policymakers and market operators over the past decade, as they have emerged as a major innovative financial instrument for public authorities and companies to address environmental concerns. Green bonds are debt instruments whose proceeds are used to finance environmentally friendly projects. While the cash flow and collateral rights are the same as those for regular bonds issued by the same party (i.e., supranational agencies, governments and firms), essential for the bond to be considered "green" is that the proceeds are used for earmarked climate-friendly purposes (e.g., sustainable water management and energy production). Green bonds represent a recent breakthrough in sustainable finance: by the end of 2023, the volume of green-labeled bonds had reached $587.6 billion, with Europe providing more than half of green bonds and China remaining the leading country issuer (Climate Bonds Initiative, 2024). Despite its rapid expansion, the green bond market is still relatively small. A major

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obstacle to its development is the lack of a widely recognized green bond standard. So far, there has been a market-led effort to define a standard "green label", while more recently, other regional guidelines have emerged, as in the case of China and Europe.[1] The resulting information asymmetry between issuers and investors due to limited information on environmental impacts has raised greenwashing concerns among investors, whereby companies would issue green bonds to reap the benefits of appearing "green" without actually being "green".[2]

However, given the increasing attractiveness of such financial instruments, there is a need to test their effectiveness in achieving the goals for which they were designed, while considering how market participants model their expectations adjusting for the "greenness" factor associated with green bonds. For such effectiveness to occur, two mechanisms need to be in place at the same time. First, issuers must be able to reap the financial benefits from a green bond issuance truly intended to generate positive environmental externalities. Second, notwithstanding the importance of implementing appropriate regulation to curb the deceitful use of such instruments, the bond market should develop external enforcement mechanisms by "punishing" those companies whose actions are at odds with the signal sent through the green bond issuance.

This paper focuses on the latter side of the story by investigating how the secondary market for corporate green bonds reacts to Environmental, Social and Governance (ESG) incidents. Since the negative ESG news captures salient point-in-time shocks to investors' beliefs about issuers' ESG characteristics, our approach is to examine whether and how investors change their preferences in the secondary bond market after learning about these negative ESG news.

While it is reasonable to expect a negative bond market reaction following the publication of negative ESG news about the firm as evidence of corporate social irresponsible[3] behavior, it is not clear *a priori* whether this reaction is more pronounced for green or conventional bonds.

Apparently, it is more plausible to expect a steeper decline in the performance of green bonds compared to conventional bonds for at least two reasons. First, since the issuance of a green bond may signal a firm's commitment to green initiatives (framing as socially responsible activities), when an ESG risk occurs, the market may "penalize" the green bond more severely, as the signal sent through its issuance may be perceived as misleading. Second, if green bonds were initially issued at a premium,[4] investors would be less likely to tolerate undesirable ESG behaviors by their issuers.

Alternatively, one might hypothesize that the post-incident portfolio rebalancing decisions may be primarily driven by cost-effectiveness considerations, making the green label less relevant. If so, potential differences in bond liquidity may drive investor behavior, as higher liquidity is associated with lower transaction costs. Accordingly, since investors would sell more green bonds or more conventional bonds depending on the level of the associated transaction costs, one should expect the post-incident price performance to be driven by differences in bond liquidity.

To investigate these effects, using a large international sample of bond issues, we observe the cumulative abnormal returns (CARs) of green bonds around ESG incidents involving their issuers and compare them with those of conventional bonds issued by the same firm, affected by the same ESG incident and matched based on seniority, currency, coupon type and year of issue. After applying these restrictions, we obtained a sample of 340 green bonds, matched with 1,446 conventional bonds identical in the above characteristics. In terms of bond-incident pairs, these are 1,052 for green bonds and 3,951 for conventional bonds.

Our results indicate that the performance of both green and conventional bonds declines after the ESG incident, but the decline is more pronounced for conventional bonds. This result holds for different types of ESG incidents, regardless of whether they are related to environmental or social and/or governance issues, and it is robust to changes in the time window for calculating the CAR. To rule out any endogeneity concerns, we repeat our estimations after applying a 1:1 propensity score matching (PSM) procedure. Results remain qualitatively similar except for environmental incidents: in this case, while the post-incident price decline is more severe, conventional bonds only underperform green bonds for ESG incidents with higher media impact.

We then find that the sample of green bonds was not issued at a premium and, more importantly, that conventional bonds are, on average, slightly more liquid on average than paired green bonds, which seems to support our cost-effectiveness argument. The latter is further confirmed when dealing with sample heterogeneity. Indeed, we observe that green bonds underperform conventional bonds when the sample is restricted to officially certified green bonds (i.e., green bonds aligned with the "Climate Bonds Initiative" standards), while, after conditioning on the country of the issuer, we do not observe significant differences for European issuers. Not

[1] Specifically, the most popular voluntary market-led initiatives to establish these criteria are those set by the International Capital Market Association (ICMA) in its Green Bond Principles and the Climate Bond Initiative (CBI) standards. Both consist of standardized and voluntary procedures that promote transparency of the information disclosed by the issuers. In particular, the Green Bond Principles focus on four main areas: the use of proceeds, the process for project evaluation and selection, the management of proceeds, and reporting. In April 2021, the People's Bank of China issued a new catalogue of projects eligible for green bond issuance, replacing the 2015 release. In July 2021, the European Commission presented its legislative proposal, known as the EU Green Bond Standard (EuGB), based on the EU taxonomy for sustainable activities. It complements a series of other measures included in the "Sustainable Finance Action Plan" (2018). Although both regulations share similar principles and targets, the Chinese policy framework uses a top-down approach, while the EU's approach is bottom-up.

[2] Greenwashing occurs when the use of proceeds is for purposes that have little environmental value (Climate Bonds Initiative, 2017).

[3] Armstrong's (1977, p. 185) work pioneered an approach to the corporate social irresponsibility (CSI) concept, stating that "*irresponsible behavior is a decision to accept an alternative that is thought by the decision maker to be inferior to another alternative when the effects upon all parties are considered. Generally, it implies a gain for one party at the expense of the total system*" and that "*an act was irresponsible if a vast majority of unbiased observers would agree that this was so*".

[4] However, evidence about the existence of a green premium (*greenium*) in the corporate debt market is still mixed and inconclusive (Flammer, 2021; Caramichael and Rapp, 2024).

surprisingly, these two subsamples (CBI-aligned bonds and European issuers) are the ones for which green bonds are more liquid than matched conventional bonds.

Overall, these results indicate that investors prefer to sell conventional bonds rather than green bonds in response to increased issuers' ESG risk, as long as conventional bonds do not have higher transaction costs than green bonds.

This study makes three distinct contributions to the literature. First, we show how the market reacts to a specific form of sustainable investment – the corporate green bond – when an ESG risk actually occurs and, more generally, how investors adjust their preferences in response to the dissemination of bad ESG news about the issuer. The ongoing debate on sustainable investing has primarily shown that firms with the best ESG practices are better able to mitigate environmental, reputational, and stakeholder-related risks (Falck and Heblich, 2007), resulting in a greater ability to reduce downside risk and to be resilient in volatile market conditions (Nofsinger and Varma, 2014; Lins et al., 2017; Albuquerque et al., 2020).

Second, while various studies have examined the impact of ESG incidents on different firm dimensions, such as stock market performance (Gantchev et al., 2022; Wong and Zhang, 2022) and firm value (Aouadi and Marsat, 2018), there is still little or no evidence on the bond market. In addition, extant literature on green bonds has uniquely focused on the difference between green and conventional bonds in terms of cost of capital and returns. Thus, we enrich the existing literature by including liquidity motives that shape investor preferences.

Finally, our analyses provide new relevant insights from the corporate perspective on green bond issuance. Beyond raising additional capital, the literature has highlighted broader benefits of green bond issuance, including enhanced corporate value creation (Baulkaran, 2019). At the same time, socially irresponsible practices result in significant corporate losses with negative consequences for firms' risk and funding costs (Becchetti et al., 2023; He and Li, 2024; Gao et al., 2024). In the case of green bonds, we show that the market mechanism of "punishing" socially irresponsible companies is not *a priori* obvious. Indeed, the lower liquidity of green bonds could dampen their sales after the occurrence of negative shocks, limiting their price decline relative to conventional bonds. This evidence suggests a "resilience factor" for green bond issuance in the event of ESG incidents.

In summary, the existing literature on sustainable finance has focused primarily on the positive effects of ESG practices, highlighting their role in mitigating corporate reputational risk, improving financial performance and increasing resilience during periods of market turbulence. Within this framework, a growing body of research has focused on green bonds, examining the potential existence of a "*greenium*" and the credibility challenges associated with their issuance, including the greenwashing problem. In contrast, the potential negative effects of ESG incidents have received much less attention, especially in terms of their impact on firm value or financial conditions. In particular, there is still limited evidence on how the corporate bond market reacts to such events. This paper contributes to filling this gap by examining how the secondary corporate bond market reacts to the ESG incidents, with a particular focus on how the cost-effectiveness motive influences investor response when it comes to green versus conventional bonds.

The remainder of the paper is organized as follows. In Section 2, we review the current literature and develop our research hypotheses. Section 3 describes the data and the methodology used, while the empirical results are presented in Section 4. The discussion of our findings and conclusions are summarized in Section 5.

2. Literature review and hypotheses development

In principle, green bonds offer several benefits for both issuers and investors. For issuers, there are at least two reasons why companies would prefer to issue green bonds rather than conventional bonds (Flammer, 2021). First, as investors would be willing to accept lower returns to achieve environmental and societal goals, issuers would be able to obtain cheaper financing (the *cost of capital* argument). Second, green bonds serve as a tool to signal corporate commitment to environmental issues (the *signalling* argument). Meanwhile, if the signal is credible, the issuance of green bonds can contribute to a positive spillover effect on firms' reputation: by enhancing their green image, they become more attractive to a clientele of green investors who value the environment, creating a "halo effect" for issuer's other financing instruments (Sangiorgi and Schopohl, 2021). On the investor side, the motivation to invest in green bonds can be attributed to several factors such as financial performance, diversification benefits, and hedging opportunities. Moreover, it has been pointed out that investors are willing to forgo financial returns in order to achieve their altruistic (environmental) goals, as the investment decisions may be influenced by several behavioral (irrational) factors (Azad et al., 2024). From the perspective of institutional investors, green bonds represent both an economic investment proposition for the asset managers and a channel through which to generate positive environmental impact (Sangiorgi and Schopohl, 2021). However, there are still several open questions in the green bond literature, and the process of understanding this relatively new financial instrument is still ongoing. Despite its primary purpose of raising capital for low-carbon and sustainable projects, few studies to date have examined whether they can achieve the purposes for which they were designed, since the research has mainly focused on the differences in risk and return (i.e., yields) between green and conventional bonds.

One of the main research topics has been the verification of a green premium associated with the issuance of green bonds, also known as *greenium*. However, the results on the existence of a yield differential between green bonds and conventional bonds are mixed

(Agliardi and Agliardi, 2019), leading to a general ambiguity regarding the consensus on the existence of the *greenium*. While some studies have found that issuing of green bonds is more convenient than issuing conventional bonds (Zerbib, 2019; Löffler et al., 2021; Gianfrate and Peri, 2019; Baker et al., 2018; Wang et al., 2020), others have found no (Tang and Zhang, 2020; Hyun et al. 2020; Laker and Watts, 2020) or little (Zerbib, 2019; Hachenberg and Schiereck, 2018) significant differences in returns. A notable exception is the study by Karpf and Mandel (2018), which suggests that green bonds are priced at a discount to matched plain vanilla bonds. Such inconsistent evidence can also be attributed to some heterogeneities in the type of bond and market analyzed, such as municipal versus corporate bonds (Baker et al., 2018), between financial and non-financial corporations (Fatica et al., 2021; Hachenberg and Schiereck, 2018) and whether primary or secondary markets were considered (Ehlers and Packer, 2017).

Another strand of literature has demonstrated the hedging and diversification benefits of this instrument in some financial markets. Despite different methodological approaches, a prevailing notion is the existence of a strong co-movement between the green bond and other fixed-income asset classes (such as corporate and treasury bonds), while high diversification benefits arise with stock, commodity, and energy markets (Reboredo, 2018; Broadstock and Cheng, 2019; Reboredo et al., 2020; Reboredo and Ugolini, 2020; Arif et al., 2021; Nguyen et al., 2021). In addition, the study by Rehman et al. (2023) highlights useful hedging and diversification benefits by examining spillovers and linkages between the 12 international green bond markets. Interesting market spillovers emerge also with Islamic financial instruments (Billah et al., 2023) and Bitcoin (Huang et al., 2023). While some studies have delved into the positive impact of the green bond issuance on stock price (Baulkaran, 2019; Tang and Zhang, 2020), relatively few studies have specifically addressed the market performance of green bonds, focusing instead on the factors behind that performance, such as market volatility and liquidity risk (Febi et al., 2018; Pham and Huynh, 2020; Russo et al., 2021; Adekoya et al., 2023). Moreover, little is yet known about the determinants of green bond issuance (Lin and Su, 2022; Cicchiello et al., 2022).

Academics have also highlighted the challenges associated with the issuance of green bonds, such as greenwashing. Since only the issuers know whether the proceeds will actually be used to finance the green projects listed in the bond prospectus, they may exploit this information advantage by engaging in greenwashing. However, previous literature has argued that bond governance features, such as adherence to recognized green bond certification standards and/or obtaining a second party opinion to guarantee the "green" use of proceeds, could prevent this practice and provide an effective and credible signal to the market (Hyun et al. 2020; Flammer, 2021), thereby stimulating investment in green bonds. Importantly, certification procedures are a key driver of *greenium* (Pietsch and Salakhova, 2022). Overall, the question of whether the issuance of green bonds represents a form of greenwashing or whether it actually leads companies to make green investments is an important concern for both academics and practitioners. For example, Xu et al. (2022) document a risk of greenwashing in the Chinese green bond market, while Shi et al. (2023) provide evidence of corporate greenwashing. On the contrary, Flammer (2021) shows that, by issuing green bonds, firms can send a credible signal of environmental commitment, receive higher environmental ratings, lower CO_2 emissions, and experience an increase in ownership by long-term and green investors. Interestingly, her findings contradict the view that green bonds are merely a greenwashing tool or a way to provide a cheaper source of debt financing.

However, to the best of our knowledge, there is no evidence on the impact of ESG incidents on the performance of green bonds (compared to conventional bonds of the same issuer). In other words, we ask how the market reacts and which of the two bond categories underperforms after issuers' ESG risk materializes.

On the one hand, investors are not always able to assess the firm's efforts to address climate issues due to the existence of information asymmetries. In line with the *signaling theory*, the green bond issuance represents a way for the firm to signal its environmental commitment to the market, which also allows to raise capital to finance low-carbon projects, thereby reducing its carbon footprint. Consistent with the *signaling theory*, firms take costly actions (such as issuing green bonds) to send credible signals to the market about their intentions (Connelly et al., 2011). Moreover, a green bond builds stakeholder legitimacy for the issuer by obtaining a "license to operate" at the societal level, which is a signal of corporate social responsibility (Li et al. 2020). However, the effectiveness of the signal depends on the perceived sincerity and authenticity. In the case of ESG incidents, bondholders may perceive the environmental commitment as deceptive, leading to a loss of trust and legitimacy. As a result, investors may "punish" those companies whose actions contradict the signal sent with the green bond issuance, since such a signal turns out to have been misleading. In line with this prediction, we hypothesize a more pronounced negative performance in the case of green bonds following the announcement of the ESG incidents.

Hypothesis 1: *Green bonds experience a more pronounced negative performance than conventional bonds following the ESG incidents*

On the other hand, while green bonds allow investors to align their investment choices with their sustainability preferences, there is no doubt that the demand for green bonds is primarily driven by institutional investors using such assets as part of their portfolio strategies. Accordingly, a prominent question addressed by previous scholars has been whether such attractiveness among institutional investors translates into cost-advantages associated with green bonds. In this respect, existing studies have shown that, despite their environmental label, green bonds have similar risk structures and pricing principles to conventional bonds. However, some studies claim that green bonds are often characterized by a yield discount and lower liquidity than conventional bonds (Zerbib, 2019; Boutabba and Rannou, 2022; Su and Lin, 2022). In fact, green bonds have unique green attributes that may contribute to lower liquidity relative to conventional bonds (Yan et al., 2024). Indeed, the lack of transparency in reporting on the performance of green projects could lead to opacity, making the green bonds perceived as riskier due to higher adverse selection costs, which may reduce their liquidity (Amihud and Mendelson, 1980). Furthermore, although the green bond market is growing substantially, it remains significantly smaller than the conventional bond market, which may further contribute to higher (il)liquidity risk. Since liquid assets are easier to convert into cash in a short time, one would expect investors to sell the most liquid bonds in the case of ESG incidents to avoid additional transaction costs, leading to a more pronounced negative performance in the case of conventional bonds. Similarly, if investors truly pay a premium at issuance for green bonds, they would be unlikely to tolerate ESG incidents and to not penalize the green bonds themselves. We therefore posit that:

Hypothesis 2*: Conventional bonds experience a more pronounced negative performance than green bonds following the ESG incidents*

3. Data and sample

3.1. Sample identification strategy

We start by extracting the Refinitiv universe of corporate green bonds issued from 2013 to 2022, consisting of 7,765 securities. Of these, we retain only green bonds issued by companies present on RepRisk,[5] which is our source of ESG incidents. RepRisk represents the most comprehensive and reliable source for measuring and analyzing corporate reputational risk, and is also one of the most widely used in the literature (Kölbel et al. 2017; Harjoto et al., 2021; Godfrey et al., 2024; Newton et al., 2024). This reduces our initial list to 2,756 securities issued by 703 unique firms. We repeat the same procedure for conventional bonds (i.e., bonds not accompanied by the "green" label"), retaining only those issued in the same period by firms present on RepRisk, resulting in an initial control sample of 54,882 conventional bonds.

Next, we match each (green and non-green) bond in our initial sample to the ESG incidents involving the respective issuer and retain only bond-incident pairs where the bond was still outstanding at the time of the event. In addition, we require a minimum of 20 trading days between the bond's issue (expiration) date and the incident date, so to have an adequate time window to evaluate price performance before (after) the ESG incident. For example, if the issuer was involved in an ESG incident on June 14, 2021, we only consider bonds maturing after July 12, 2021 for that incident. Similarly, for each bond, we exclude ESG incidents that occurred less than one year and 30 days after the bond's issue date in order to have a long enough time period to calculate the "normal" returns.

Furthermore, since a single bond can obviously be matched with more than one ESG incident**,** we need to define a clean identification strategy by getting rid of the potential confounding effects of multiple ESG incidents affecting the same issuer in a narrow time window. Suppose that the previous issuer was involved in a second ESG incident on June 1, 2021, and we want to evaluate the bond's price performance in the forty days around the event (i.e., [-20, +20], where 0 is the date the incident was first disclosed). If bond prices are truly affected by ESG incidents, we will have a situation where the pre-event performance of the second incident ([-20, 0]) is affected by the post-event performance of the first incident ([0, +20]). To avoid this, we do not consider multiple incidents that occur within 30 days for a single bond, but we keep the first one.[6] In this way, we ensure that any observed bond price effect in the [-20, +20] window can be reasonably attributed to the specific ESG incident. After imposing these restrictions, our sample now consists of 374,669 bond-incident pairs (of which 7,148 refer to green bonds) for 56,487 unique corporate bonds (1,605 green bonds) issued by 3,257 firms.

Accordingly, we first exclude those firms issuing only conventional bonds and no green bonds, which reduces the number of issuers to 444 and the number of bond-incident pairs to 216,911 (for 31,904 unique bonds). We then exclude corporate bonds with missing relevant data (we do not have face value data from Refinitiv for 7,861 securities and coupon type information for 48 securities, further excluding 52,743 bond-incident pairs). Moreover, we use a matching procedure to remove any residual heterogeneity between the two samples, so to rule out the possibility that observed price differences between green and conventional bonds are still driven by other bonds- and issuer-specific characteristics. Specifically, for each green bond-incident pair, we require that the matched conventional bond-incident pairs refer to the exact same ESG incident, have the same issuer, and have identical bond-level features derived from previous literature (Zerbib, 2019; Larcker and Watts, 2020), namely: seniority, currency, rating, coupon type and year of issuance. Then, after the matching procedure described above, our sample reduces to 6,146 bond-incident pairs (of which 1,194 refer to green bonds).

Finally, we want to get rid of those cases where the fiscal year end date falls within the [-20, +20] window so that our results may be biased by the fiscal year shift, which may affect investor response. If this is the case, one can reasonably argue that the effect may not be fully attributed to the ESG incident. Thus, we exclude all those bond-incident pairs where either the fiscal year-end date or the new financial statement release date[7] is in the [-20, +20] time window. After applying this last restriction, our final sample consists of 5,003 bond-incident pairs (of which 1,052 refer to green bonds), for 1,786 unique bonds (340 green bonds) by 180 issuers, while the number

[5] Records in the RepRisk database stop at December 2022, so we apply the same filter for corporate bonds' search.

[6] Since in this case, we can argue that the post-event performance cannot be influenced by the next (and not yet happened) ESG incident.

[7] For example, if the incident date is March 24, 2021, and the issuer's fiscal year-end is December 31, 2020, but the financial statement for FY2020 is released on March 31, 2021, we remove this bond-incident pair from the sample.

Table 1
Characteristics of the bond sample. This table describes the distribution of the (green and conventional) bonds in our sample (N = 1,786) by several characteristics (Panels A-E). In Panel F, we report green label information for the sole green bond sample (N = 340).

Panel A. Sample bonds by issuance year		
Year of the issuance	N.obs	%
2013	1	0.1
2014	3	0.2
2015	32	1.8
2016	34	1.9
2017	67	3.8
2018	49	2.7
2019	252	14.1
2020	364	20.4
2021	655	36.7
2022	329	18.4
Panel B. Sample bonds by tenor		
Tenor	N.obs	%
less than 5 years	349	19.5
5 to 10 years	690	38.6
10 to 20 years	473	26.5
more than 20 years/perpetual	274	15.3
Panel C. Sample bonds by seniority		
Seniority	N.obs	%
Senior Unsecured	1,348	75.5
Senior Preferred	127	7.1
Senior Secured	156	8.7
Senior Non-Preferred	60	3.4
Unsecured/Junior Subord. Unsecured	95	5.3
Panel D. Sample bonds by amount issued		
Nominal amount	N.obs	%
less than $10Mln	395	22.1
$10 to $50Mln	300	16.8
$50 to $100Mln	203	11.4
$100 to $200Mln	177	9.9
$200 to $500Mln	139	7.8
$500Mln to $1Mld	333	18.6
more than $1Mld	239	13.4
Panel E. Sample bonds by type of coupon		
Type of Coupon	N.obs	%
Fixed	1,462	81.9
Floating	137	7.7
Zero-coupon	187	10.5
Panel F. Green bond labels		
Climate Bond Initiative	N.obs	%
CBI Aligned Green bond	239	70.3
CBI Certified Green Bond	14	4.1
Self-Labeled Green Bond	87	25.6
Second Party Opinions		
Yes	247	72.6
No	93	27.4
ICMA Green Bond Principles aligned		
Yes	325	95.6
No	15	4.4

of unique ESG incidents is 766. The number of green bonds in our sample (340) is in line with previous studies using an international sample of corporate bonds (Flammer, 2021; Cheng et al., 2023; Caramichael and Rapp, 2024).

A further description of the bond sample is provided in Table 1. The number of issues gradually increased over time (Panel A), in line with the general trend in the green bond market, with 2021 being the year with the most issues. More than half of the sample bonds have a maturity of 10 years or less (Panel B) and a nominal value lower than $100Mln (Panel D). Moreover, the vast majority of sample bonds have a fixed coupon (81.9 %, Panel E), and are senior unsecured (75.5 %, Panel C). Finally, in Panel F, we show that most of the green bonds in our sample comply with the CBI taxonomy (Climate Bond Initiative, 2023) and with the ICMA Green Bond Principles

Table 2
Sample of ESG incidents. We report the characteristics of the ESG incidents included in our sample (N = 766), divided by type of incident (environmental incidents vs. social/governance incidents) and degree of severity/reach.

	Environmental incidents		Social and Governance incidents	
Severity				
(1) low	154	(64.4 %)	402	(76.3 %)
(2) medium	66	(27.6 %)	112	(21.2 %)
(3) high	19	(8.0 %)	13	(2.5 %)
Reach				
(1) low	128	(53.6 %)	175	(33.2 %)
(2) medium	86	(36.0 %)	234	(44.4 %)
(3) high	25	(10.4 %)	118	(22.4 %)
Total	**239**		**527**	

Table 3
Sample distribution by country. The Table reports the sample distribution by country. We report the distribution both in terms of corporate (green and conventional) bonds (N = 1,786) and in terms of the country of headquarters of the issuing firm (N = 180). In the former case, we refer to the country of the issuer (and not the country of the issuance). Countries are sorted by the number of bonds.

Distribution by number of bonds			Distribution by number of issuers		
Country	Number	Perc.	Country	Number	Perc.
United States of America	606	33.93	Japan	35	19.44
Korea; Republic (S. Korea)	250	14.00	United States of America	26	14.44
Japan	179	10.02	Korea; Republic (S. Korea)	21	11.67
Germany	134	7.50	China	17	9.44
France	133	7.45	France	12	6.67
China	82	4.59	Italy	8	4.44
Netherlands	66	3.70	Hong Kong	6	3.33
Austria	52	2.91	Austria	5	2.78
Italy	41	2.30	Canada	5	2.78
Canada	31	1.74	Germany	5	2.78
Spain	31	1.74	Spain	5	2.78
Taiwan	27	1.51	Netherlands	5	2.78
Australia	26	1.46	Australia	4	2.22
Russia	25	1.40	Sweden	4	2.22
Hong Kong	21	1.18	United Kingdom	3	1.67
Sweden	21	1.18	Singapore	3	1.67
Finland	10	0.56	Finland	2	1.11
United Kingdom	10	0.56	Norway	2	1.11
India	8	0.45	Taiwan	2	1.11
Norway	5	0.28	United Arab Emirates	1	0.56
United Arab Emirates	4	0.22	Belgium	1	0.56
Belgium	4	0.22	Switzerland	1	0.56
Denmark	4	0.22	Denmark	1	0.56
Singapore	4	0.22	India	1	0.56
Switzerland	3	0.17	Portugal	1	0.56
South Africa	3	0.17	Russia	1	0.56
Portugal	2	0.11	Thailand	1	0.56
Thailand	2	0.11	Turkey	1	0.56
Turkey	2	0.11	South Africa	1	0.56
Total	***1,786***	***100.00***		***180***	***100.00***

(ICMA, 2021), and 72.6 % of them have received external reviews by independent agencies, which existing research suggests is a key factor in explaining yield differences with non-green counterparties (Caramichael and Rapp, 2024; Ghitti et al., 2023).

3.2. Variables measurement

To study the bond price reaction to negative ESG news, we estimate the CARs in a 40-day window around the event occurrence. CARs are defined as the difference between realized and expected bond returns, where, following previous studies (Sam and Zhang, 2020; Flore et al., 2021; Suk and Wang, 2021), expected returns are obtained from a simple market model based on daily bond and related index returns over the previous year, as follows:

Table 4

Variable definition and summary statistics. The table reports a definition of all the variables used in our empirical analyses (Panel A) and, limited to those used in our regressions, the main summary statistics (Panel B). Data on ESG incidents come from the RepRisk database, firm-level ESG data, and corporate governance information are from the Refinitiv ESG database, while bond-level data, firm financials, and CDS data are from Refinitiv Datastream.

Panel A. Variable description

Variable	Description
Environmental incidents	Risk incidents to which the firm is exposed concerning environmental issues
Social incidents	Risk incidents to which the firm is exposed concerning social issues
Governance incidents	Risk incidents to which the firm is exposed concerning governance issues
Severity	RepRisk score referring to the harshness of the risk incident, evaluated in function of the alleged violation of national rules and international standards. It is expressed as a score ranging from 1 to 3, where: 1 stands for "low severity"; 2 stands for "medium severity"; and 3 stands for "high severity". The score is determined jointly considering the consequences, the extent and the causes of the incident
Reach	RepRisk score referring to the influence/readership of the source in which the incident has first been published. It ranges from 1 to 3, where: 1 stands for "low reach source" (local media, smaller NGOs, minor internet sites, etc.); 2 stands for "medium reach source" (national/regional media, international NGOs, etc.); 3 stands for "high reach source" (few international media, such as FY, NY Times, BBC and others)
CAR[-20, *n*]	The daily cumulative abnormal return, obtained by adding up daily abnormal returns starting from day −20. Abnormal returns are defined as the difference between realized and expected daily bond price returns, where expected returns for bond *i* are estimated through the following market model: $E(R_{i,t}) = \alpha + \beta R_{m,t}$ where $R_{m,t}$ is the daily return of the bond market index in which the corporate (green or conventional) bond is included. The model (and, thus, the α and β parameters) are estimated in the time-window [-365, −30]
GreenBond	Indicator variable equal to 1 if the daily observation refers to a green bond (treatment sample); 0 if conventional bond (control sample)
After	Indicator variable equal to 1 if the daily observation is after the incident date in the window [+1, +20]; 0 if before, in the window [-20, −1]
Ln(amount issued)	The natural logarithm of the nominal amount of the corporate bond
Modified duration	The modified duration to maturity, computed as follows: $MD = \frac{D}{\left(1 + \frac{Y_h}{H*100}\right)}$ where D is the duration to maturity (in years), H is the coupon frequency and Y_h is the yield compounded H times per year
Ln(asset)	The natural logarithm of total book assets in the ESG incident year
Profitability	Ratio of net income to total assets
Leverage	Ratio of total long-term debts to total assets
Market-to-book	Ratio of market capitalization to total book equity
ENV pillar	Environmental pillar score by Refinitiv, representing one of the three pillars of the overall ESG score proxying for corporate environmental performance and commitment toward environmental preservation and green issues
SOC pillar	Social pillar score by Refinitiv, measuring the extent to which companies address social issues, such as ensuring workforce safety, respecting human rights and producing responsible goods.
GOV pillar	Governance pillar score by Refinitiv, measuring the soundness and effectiveness of corporate governance mechanisms in fostering shareholders' participation and promoting sustainable managerial practices.
Zeros	Percentage of days with daily bond returns equal to zero in the year prior to the ESG incident
Bid-Ask	Yearly average of the quoted daily bid-ask spread, expressed as a percentage of the daily bid price
EPSmarket	Indicator variable equal to 1 if the MBI index is above the sample median (stricter regulations); 0 otherwise
CBIaligned	Indicator variable equal to 1 if the matched pair contains a green bond aligned with the Green Bond Principles (GBP) taxonomy defined by the Climate Bond Initiative (CBI); 0 otherwise
CDS	Indicator variable equal to 1 if a CDS is actively traded having the issuer as reference entity; 0 otherwise
CDSliquidity	Indicator variable equal to 1 if issuer's CDS liquidity is above the matched sample median and zero otherwise. CDS liquidity is computed on daily CDS spreads from the year before the ESG incident using the zeros measure

Panel B. Summary statistics

Variable	Min	25th perc.	Median	75th perc.	Max	Mean	St.Dev.	N.obs
CAR[-20, *n*] (%)	−12.504	−1.585	−0.185	0.785	10.507	−0.407	3.121	184,869
Ln(amount issued)	4.317	11.513	13.528	16.118	19.807	13.365	3.204	184,869
Modified duration	0.000	3.777	6.169	9.555	38.285	7.791	5.560	184,869
Ln(asset)	6.963	11.821	12.626	13.422	15.656	12.538	1.395	184,869
Profitability	−24.090	0.413	1.048	3.861	28.292	2.470	5.772	184,869
Leverage	0.567	11.165	22.307	35.151	62.322	23.390	13.355	184,869
Market-to-book	0.218	0.449	0.913	1.816	45.966	2.467	6.539	184,869
ENV pillar	0.000	73.544	84.077	91.460	99.055	80.969	13.201	184,869
SOC pillar	3.644	71.119	78.777	84.978	97.649	76.247	13.653	184,869
GOV pillar	8.170	54.115	66.316	82.999	97.529	66.459	18.424	184,869

$$R_{i,t} = \widehat{\alpha}_i + \widehat{\beta}_i \times R_{m,t} + \varepsilon_{i,t} \quad (1)$$

where $R_{i,t}$ and $R_{m,t}$ are the returns on day t for bond i and the corresponding bond market index m, respectively. We use a [-365, −30] estimation window, i.e., from 365 to 30 days prior to the date of the ESG incident date. We then compute the daily abnormal return for each bond by using the parameters $\widehat{\alpha}_i$ and $\widehat{\beta}_i$ from Eq. (1) in the following model:

$$AR_{i,t} = R_{i,t} - \widehat{R}_{i,t} = R_{i,t} - \left(\widehat{\alpha}_i + \widehat{\beta}_i \times R_{m,t}\right) \quad (2)$$

where $\widehat{R}_{i,t}$ is the expected return for bond i on day t using the estimates from Eq. (1). The cumulative abnormal return ($CAR_{i,t}$) is then computed for each bond during the [-20, +20] event window by using Eq. (3) below:

$$CAR_{i,t} = \sum_{j=0}^{t} AR_{i,j} \quad (3)$$

We collect daily bond and index quotes[8] from Datastream by LSEG Data & Analytics, while ESG incidents' data come from RepRisk, which gives us the exact date the controversy was first published in a major information source.

Each incident is classified based on the ESG dimension to which it relates, so that we can distinguish between environmental incidents and incidents related to social and/or governance issues. Table 2 describes how our 766 sample incidents are distributed across these dimensions: our main focus is on environmental incidents (representing about 30 percent of the sample incidents), but we also consider the other two categories. We also control for two other characteristics by which ESG incidents are classified, namely *severity* and *reach*. *Severity* refers to the magnitude of the ESG incident, which depends on the regulations violated, while *reach* depends on the type of source from which the incident was first published. RepRisk assigns a score[9] ranging from 1 (representing low *severity/reach*) to 3 (representing high *severity/reach*).

Table 3 shows the sample distribution by country, both in terms of corporate (green and conventional) bonds (N = 1,786) and in terms of the country of residence of the issuing firm (N = 180). In our sample, most bonds and issuers are from the United States of America, South Korea, and Japan.

Finally, as our estimates are based on a difference-in-differences (DiD) model (see Section 4), we control for other bond- and issuer-specific variables. In the former case, we control for the (log of the) bond nominal value and the daily modified duration. As for the issuer-level variables, we control for features that are likely to influence investors' decisions, such as firm size, performance, leverage, market-to-book ratio, and issuers' environmental, social and governance performance. In fact, a hypothetical investor's reaction following the controversy may depend on the preexisting ESG profile of the issuer itself. A more detailed description of the variables used in our empirical analyses is in Panel A of Table 4, while Panel B reports summary statistics of the variables used.

4. Results

4.1. Baseline results

In this section, we report the results of our main analysis on the impact of the ESG incidents on corporate bond performance. We first present a graphical analysis and then illustrate the results of our event study model.

Fig. 1 shows the CAR of both green and conventional bonds using a 40-day [-20, +20] event window. Important insights emerge. First, green bonds and their non-green counterparts exhibit a similar pattern prior to the event announcement day (day 0). In contrast, the performance of the conventional bond deteriorated after the announcement of the ESG incident. Second, green bonds show less volatile returns than their non-green counterparts over the time window examined. This evidence seems to be consistent with previous literature highlighting a resilience factor in sustainable investments. Moreover, this result is also confirmed when differentiating by ESG incident type: environmental (Panel B) or social and/or governance (Panel C). Finally, we observe that the abnormal returns of the green and conventional bond groups start to diverge a few days before the announcement date, and the effect tends to persist in the following days. It is worth remembering that day 0 is when the ESG incident is first disclosed by a major information source and not necessarily the day when it occurs. Thus, the negative price movements that start a few days before day 0 may be due to information leakage[10] and/or market participants' anticipation of the event.

Table 5 presents the event study results of green and (matched) conventional bond returns around ESG incidents. In particular, we report the CARs of conventional bonds (column 2) and those of green bonds (column 3), as well as their difference (column 4), estimated over different time windows around the announcement day (day 0). The different event windows (column 1) allow us to examine the bond market reaction from different perspectives. In fact, the analysis focuses on intervals that include a period before and after the event under analysis. Furthermore, based on the above intervals, returns around the different types of announced news are also examined for comparison purposes. In this respect, Panels A, B, and C show the returns around all sample ESG incidents,

[8] We use the "clean" bond price, without considering accrued interests.
[9] The score methodology can be found at: https://www.reprisk.com/news-research/resources/methodology.
[10] This is especially true for institutional investors, whose information advantage allows them to adjust their portfolios in response to negative ESG news before it becomes public.

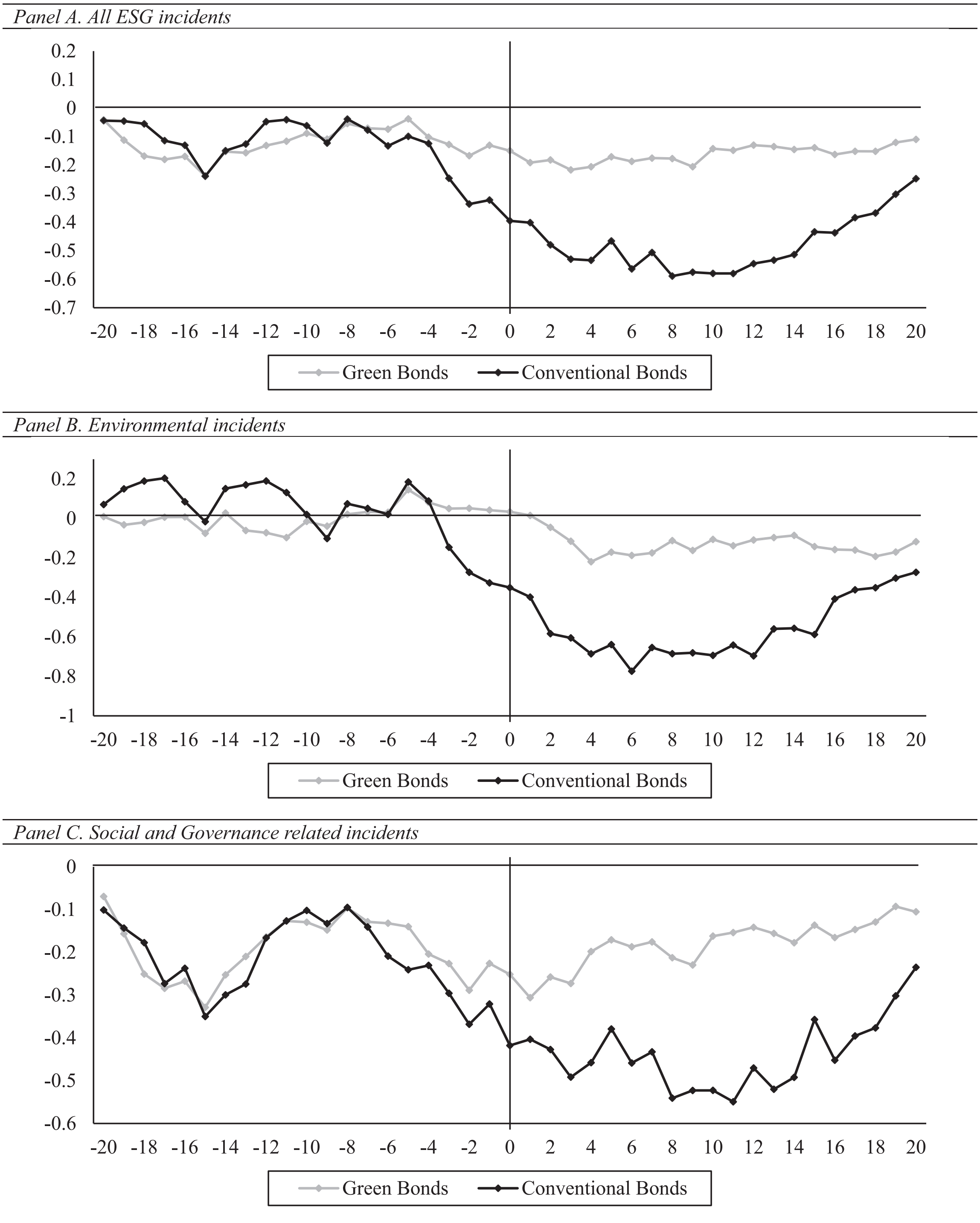

Fig. 1. CARs around the ESG incident. The figures report the cumulative abnormal returns for green and conventional bonds around the ESG incident in the time window [-20, +20]. In Panel A, we consider all ESG incidents in our sample, while Panels B and C refer to environmental incidents and incidents related to social and/or governance issues, respectively.

environmental incidents and social and/or governance incidents, respectively. The persistence of negative statistically significant differences between bond returns seems to dominate, on average, every combination of event windows tested. The negative and statistically significant difference in cumulative returns suggests that the underperformance is more pronounced for the conventional bonds, regardless of whether the ESG incident involved only the environmental pillar or the entire ESG aspect. However, as expected,

Table 5
Event study around ESG incidents. In this table, we report the cumulative abnormal returns for green and conventional bonds around the ESG incident, computed using different time windows. In the first column, we report the time window used to compute the CARs. Columns 2 and 3 show the average CARs for conventional and green bonds, respectively, while column 4 provides the difference and its significance level, for which the t-statistic is also reported (column 5). Estimations are based both on the full sample of ESG incidents (Panel A) and on subsamples based on the type of incidents (environmental incidents in Panel B and social/governance related incidents in Panel C).

Window	CARs(non-green bonds)	CARs(green bonds)	diff.	t-stat
(1)	(2)	(3)	(4)	(5)
Panel A. All ESG incidents				
[− 1, + 1]	−0.050	−0.058	−0.009	0.184
[− 3, + 3]	−0.347	−0.195	−0.152**	−2.036
[− 5, + 10]	−0.490	−0.130	−0.361***	−3.674
[− 10, + 6]	−0.492	−0.198	−0.295***	−2.784
[− 10, + 10]	−0.571	−0.106	−0.465***	−4.100
[− 16, + 14]	−0.389	0.041	−0.429***	−3.221
[− 20, + 3]	−0.691	−0.402	−0.288**	−1.215
[− 20, + 20]	−0.192	−0.031	−0.161	−2.326
[− 30, + 30]	−0.184	−0.008	−0.176	−1.093
Panel B. Environmental incidents				
[− 1, + 1]	−0.109	−0.060	−0.050	−0.627
[− 3, + 3]	−0.424	−0.257	−0.168	−1.242
[− 5, + 10]	−0.761	−0.165	−0.596***	−3.508
[− 10, + 6]	−0.712	−0.264	−0.449**	−2.303
[− 10, + 10]	−0.889	−0.091	−0.798***	−4.234
[− 16, + 14]	−0.770	0.146	−0.624***	−2.768
[− 20, + 3]	−0.811	−0.390	−0.421*	−1.871
[− 20, + 20]	−0.231	−0.051	−0.180	−0.680
[− 30, + 30]	−0.311	−0.130	−0.182	−0.712
Panel C. Social and Governance incidents				
[− 1, + 1]	−0.025	−0.057	−0.033	−0.583
[− 3, + 3]	−0.315	−0.160	−0.154*	−1.711
[− 5, + 10]	−0.349	0.110	−0.239**	−1.995
[− 10, + 6]	−0.400	−0.161	−0.239*	−1.892
[− 10, + 10]	−0.404	−0.115	−0.289**	−2.050
[− 16, + 14]	−0.190	0.146	−0.336**	−2.032
[− 20, + 3]	−0.640	−0.409	−0.231	−1.552
[− 20, + 20]	−0.172	−0.019	−0.152	−0.865
[− 30, + 30]	−0.120	−0.061	−0.180	−1.208

Notes: *, **, *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

we observe a higher statistical significance in the differential returns for environmental incidents (Panel B), compared to social and governance incidents (Panel C).

Then, Table 6 reports the estimation results for the following DiD model testing our hypotheses:

$$CAR_{i,t} = \beta_0 + \beta_1 GreenBond_i + \beta_2 After_t + \beta_3 GreenBond_i \times After_t + \beta_4 Controls + \theta FE + \varepsilon_{i,t} \tag{4}$$

The dependent variable, $CAR_{i,t}$, is the cumulative abnormal return for bond *i* in day *t*, calculated from day −20. *GreenBond* takes the value of one for green bonds and zero for conventional bonds, while *After* takes the value of zero for daily observations in the [-20, −1] time window and one for [+1, +20]. Our coefficient of interest, β_3, which results from their interaction, measures the difference in price performance between green and conventional sample bonds after the event. *Controls* and *FE* are vectors of the control variables described in Section 3.2 and fixed effects, respectively.

In column 1, our main coefficient of interest – associated with the interaction between *GreenBond* and *After* – is positive and statistically significant at the 1 % level. This suggests that firm issuing similar green and conventional bonds experience a more pronounced decline in conventional bond performance after the ESG incident. This result is confirmed when we add different fixed effects to control for sectors, issues, and years' specificities (column 2), as well as other control variables (columns 3 and 4). Looking at the other control variables (for which we observe statistical significance at least at the 5 % level), we find that bond CARs are positively

Table 6

DiD regressions estimating the impact of ESG incidents. Baseline results. We report baseline results for the difference-in-differences (DiD) regressions estimating the impact of ESG incidents on the price performance of green bonds relative to matched conventional bonds. The dependent variable is the CAR computed from day −20 (i.e., 20 days before the event occurrence). Estimations are based on a [-20, +20] window.

Dependent variable CAR[-20,*n*]	(1)	(2)	(3)	(4)
GreenBond	0.066**	0.052**	0.007	−0.014
	(0.036)	(0.029)	(0.019)	(0.019)
After	−0.198***	−0.156***	−0.158***	−0.172***
	(0.016)	(0.015)	0.007	−0.014
GreenBond*After	0.204***	0.162***	0.159***	0.160***
	(0.035)	(0.034)	(0.033)	(0.032)
Ln(amount issued)			0.022***	0.020***
			(0.004)	(0.004)
Modified duration			−0.029***	−0.027***
			(0.002)	(0.002)
Ln(asset)			0.085***	−1.150***
			(0.021)	(0.139)
Profitability			0.166***	0.164***
			(0.004)	(0.006)
Leverage			0.042***	0.045***
			(0.002)	(0.005)
Market-to-book			−0.047***	−0.051***
			(0.002)	(0.003)
ENV pillar			0.019***	0.060***
			(0.001)	(0.003)
SOC pillar			−0.022***	−0.051***
			(0.001)	(0.003)
GOV pillar			0.002**	0.019***
			(0.001)	(0.001)
Constant	−0.340***	2.247***	−1.033***	10.247***
	(0.008)	(0.192)	(0.299)	(1.660)
Incident Year	No	Yes	Yes	Yes
Seniority	No	Yes	Yes	Yes
Currency	No	Yes	Yes	Yes
Coupon type	No	Yes	Yes	Yes
Domicile	No	Yes	Yes	No
Industry	No	Yes	Yes	No
Issuer	No	No	No	Yes
Observations	184,869	184,869	184,869	184,869
R-squared	0.001	0.108	0.121	0.168

Notes: robust standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

related to the nominal bond amount (*Ln(amount issued)*) and negatively related to the modified duration. Furthermore, they are more closely related to higher issuer profitability and higher environmental and governance performance, among others. Returning to our main variables of interest, we can see that the interaction coefficient remains positive and highly significant in all the specifications, confirming our Hypothesis 2 and suggesting a cost-effectiveness motivation behind investors' response after ESG incidents.[11]

Table 7 tests the robustness of our results using a more common approach that consists of estimating a unique CAR over a time window (see, for example, Sam and Zhang, 2020; and Yu et al., 2024). In contrast to the DiD setting used in Equation (4), we estimate the differential impact of ESG incidents on bond returns on the same time windows tested in the event study (Table 5) using the following OLS model:

$$CAR_i = \beta_0 + \beta_1 GreenBond_i + \beta_2 Controls + \theta FE + \varepsilon_i \quad (5)$$

In this specification, the dependent variable, $CAR_{i,}$ is the cumulative abnormal return for bond *i*, computed over different event windows around the ESG incident (e.g., [-3,+3], [-10,+10], [-20,+20], etc.). The independent variable $GreenBond_i$ is a dummy equal to one if the bond is classified as a green bond and zero if it is a conventional bond. *Controls* and *FE* are vectors of the control variables described in Section 3.2 and fixed effects, respectively. The results indicate that our variable of interest, $GreenBond_{i,}$ is positively and statistically significant in all the windows tested, except for those that are more distant from the event (columns 8 and 9). This confirms that green bonds tend to experience less negative abnormal returns following ESG incidents.

[11] The CARs used in the regressions is calculated from day −20, but the (untabulated) results remain qualitatively unchanged when the time-window is moved to day −4, when they turn statistically insignificant, which is consistent with Fig. 1.

Table 7
ESG incidents and CARs. Robustness check. We estimate the differential impact of ESG incidents on cumulative abnormal returns computed in different time windows around the incident itself. Unlike the DiD setting used so far, we test the robustness of the previous results by using a more common approach and estimating a unique CAR over a time window, which is indicated at the top of each table.

	[-1,+1]	[-3,+3]	[-5,+10]	[-10,+6]	[-10,+10]	[-16,+14]	[-20,+3]	[-20,+20]	[-30,+30]
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
GreenBond	0.135**	0.151*	0.191**	0.249***	0.233**	0.231*	0.227*	0.049	0.009
	(0.066)	(0.077)	(0.097)	(0.091)	(0.109)	(0.139)	(0.126)	(0.156)	(0.153)
Ln(amount issued)	−0.018*	0.029**	0.023	0.043***	0.060***	0.031	0.029	−0.014	0.020
	(0.010)	(0.013)	(0.015)	(0.016)	(0.018)	(0.020)	(0.021)	(0.022)	(0.021)
Modified duration	−0.034***	−0.021**	−0.048***	−0.011	−0.030**	−0.068***	−0.021	−0.111***	−0.109***
	(0.008)	(0.009)	(0.011)	(0.011)	(0.012)	(0.014)	(0.014)	(0.015)	(0.015)
Ln(asset)	−0.204***	−0.271***	−0.268***	−0.277***	−0.337***	−0.310***	−0.333***	−0.329***	−0.341***
	(0.032)	(0.037)	(0.045)	(0.044)	(0.051)	(0.063)	(0.068)	(0.057)	(0.068)
Profitability	0.101***	0.114***	0.105***	0.078***	0.072***	0.052**	0.074***	0.117***	0.114***
	(0.012)	(0.013)	(0.015)	(0.015)	(0.018)	(0.022)	(0.022)	(0.025)	(0.024)
Leverage	0.001	0.002	0.016***	0.007*	0.010**	0.012**	0.008	0.015***	0.014**
	(0.003)	(0.003)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)
Market-to-book	−0.125***	−0.096***	−0.079**	−0.021	−0.030	−0.070	0.014	−0.175***	−0.180***
	(0.025)	(0.029)	(0.035)	(0.034)	(0.042)	(0.050)	(0.049)	(0.056)	(0.055)
ENV pillar	0.004	0.002	0.006	0.009**	−0.004	−0.007	0.001	0.000	−0.002
	(0.003)	(0.004)	(0.004)	(0.004)	(0.005)	(0.006)	(0.006)	(0.007)	(0.007)
SOC pillar	0.004	0.010***	0.007*	0.007*	0.011**	−0.004	−0.003	−0.016**	−0.007
	(0.002)	(0.003)	(0.004)	(0.004)	(0.004)	(0.005)	(0.005)	(0.006)	(0.006)
GOV pillar	0.004**	−0.000	0.003	−0.000	0.001	0.010***	0.004	0.018***	0.012***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.003)	(0.003)	(0.003)	(0.003)	(0.003)
Constant	−0.568*	−1.605***	−2.092***	−2.518***	−2.048***	−0.356	−1.409**	0.535	−0.004
	(0.324)	(0.381)	(0.456)	(0.443)	(0.546)	(0.622)	(0.604)	(0.672)	(0.673)
Incident Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Seniority	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Currency	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Coupon type	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Issuer	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4,621	4,621	4,954	4,621	4,954	5,086	4,621	5,317	5,298
R-squared	0.040	0.039	0.030	0.021	0.020	0.014	0.014	0.025	0.022

Notes: robust standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

4.2. Propensity score matching

While both the graphical analysis and the DiD approach clearly indicate a more pronounced price decline on the conventional bond side, potentially confirming our cost-effectiveness argument, we still need to address other issues that may affect the validity of our empirical results. First, the significance of the coefficient to *GreenBond* in Table 6 (columns 1 and 2) could indicate that differences between bond types persist in the pre-event window (i.e., could indicate a pre-trend). In fact, the trends shown in Fig. 1 are quite similar in the pre-event window, but not exactly parallel. Second, despite our careful matching procedure and given that conventional bonds outnumber green bonds, our sample may carry much more statistical power on the conventional rather than the green bond side. Moreover, there may be pre-event trading differences between the two types of bonds, as green bonds were already trading worse on average before the ESG incident. If so, the stronger negative impact on the performance of conventional bonds would likely be due to such trading differences.

To address these concerns, we proceed as follows. First, we use 1:1 propensity score matching (PSM) to match each incident-green bond pair with only one incident-conventional bond pair, thereby ensuring an equal number of observations on the green and conventional bond sides. To do so, we apply a nearest-neighbor matching method by taking, for each incident-green bond pair, the incident-conventional bond pair with the closest propensity score. Second, we define propensity score differences by running a probit regression on our *GreenBond* variable while controlling for the clean price of the bond prior to the event,[12] with the aim of reducing potential pre-event trading differences. Based on this approach, we obtain a matched sample of 662 bond-incident pairs (331 involving green bonds and 331 involving conventional bonds). More importantly, we show (Fig. 2) how the final PSM sample has a similar distribution between the PSM-treated group and the matched controls (Fig. 2b) compared to the pre-PSM sample (Fig. 2a).

Finally, in Fig. 3a, we can confirm that the parallel trend condition is satisfied. The pattern of CARs for the green and conventional bonds (Panel A) suggests that the two groups have parallel trends in the PSM sample. Similarly, in Panel B of Fig. 3b, which reports the T-statistics for the differences between the green and conventional bonds around the ESG incident, we find statistically significant differences between the CARs' only after the events (time window [0, +20]).

[12] In particular, we run a probit regression for each group defined after the initial matching, requiring the two samples to be identical in terms of the following characteristics: ESG incident, issuer, seniority, currency, rating, coupon type and issuance year. So, we obviously continue to require such criteria to be respected for the matched pairs.

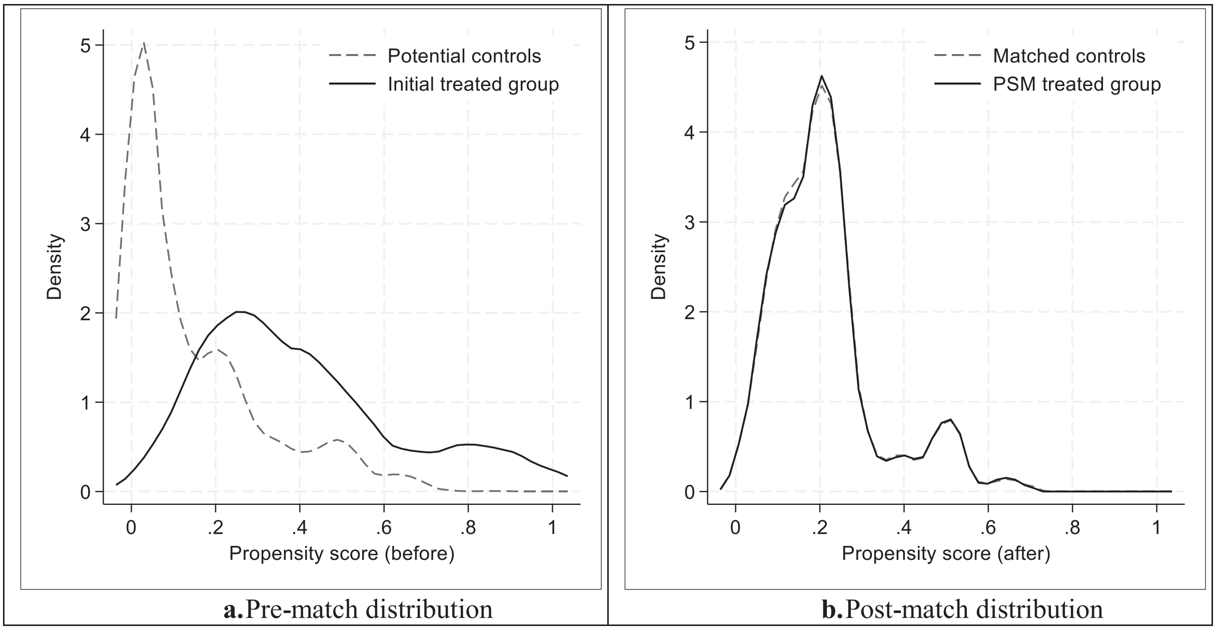

Fig. 2. Propensity score distribution. The two figures show the density distribution of the propensity scores on the initial sample (2a) and on the final sample resulting from the PSM (2b). Specifically, Fig. 2a refers to the initial treated group of 1,194 bond-incident pairs (i.e., involving green bonds) and the potential control group of 4,360 pairs for conventional bonds. Similarly, Fig. 2b reports the same propensity score distribution with respect to the matched 662 bond-incident pairs (331 involving green bonds and 331 for conventional bonds).

After providing evidence of the pre-event similarity between the incident-bond pairs, we replicate the DiD regressions proposed in Table 6 in the new propensity score matched sample. We re-validate the baseline regressions presented in the previous section based on the new matched sample. Indeed, Table 8 shows that the coefficient of *GreenBond*After* is still positive and statistically significant at the 1 % level, suggesting that the results of the DiD model based on the matched sample are consistent with an underperformance of conventional bonds relative to green bonds. Our results hold even after controlling for the various fixed effects and firm-level characteristics (including preexisting ESG performance), which again supports our Hypothesis 2 of the cost-based motivation behind investors' preference for green bonds over conventional bonds following ESG incidents.

Next, we focus our further analysis on the PSM sample and condition on the ESG incident type. Focusing on these characteristics allows us to further isolate other aspects that may affect bond performance. To this end, in Table 9, we present the main estimates differentiating by type of ESG incident, namely environmental (columns 1–3) versus social and governance (columns 4–6). In addition, in columns 2 and 5, we present our estimates differentiated by the severity of the risk incident, using RepRisk's "severity" score, which is determined jointly considering the consequences, the magnitude and the causes of the incident. Similarly, in columns 3 and 6, we condition on the "reach" score, i.e., the influence or readership of the source in which the risk incident was first published. Overall, while the results for social and governance incidents remain consistent with our baseline results, in the case of environmental incidents we find a statistically significant difference only for incidents with higher media impact. Specifically, we find that the interaction term between *GreenBond* and *After* is positive and statistically significant at the 1 % level in the case of high-reach incidents for both environmental (column 3) and social and governance (column 6) incidents, implying that the conventional bond performs worse after the ESG incident announcement, especially when the incident had a broad media impact. This evidence is consistent with studies that consider the impact of media sentiment on bond markets (Alomari et al., 2021). Therefore, media impact is much more important than severity in shaping post-event price performance differences.

4.3. Possible mechanisms: The cost-effectiveness channel

This section explores the potential mechanisms driving the performance differences between green and conventional bonds. Specifically, we investigate whether pecuniary motives, such as the cost-effectiveness of bonds – both in terms of a green premium (*greenium*) at issuance and bond liquidity – may influence investors' decisions.

First, we estimate whether there is a green premium at issuance to further explore the logic behind our evidence that conventional bonds underperform green bonds after the ESG incident. Indeed, there is conflicting evidence on whether investors are willing to pay a premium for green bonds, possibly due to their preferences on environmental issues (e.g., Flammer, 2021; Caramichael and Rapp, 2024). However, in the case of the existence of a *greenium*, it would be very unlikely that investors who paid a premium for the green bonds (at the time of issuance) would tolerate undesirable ESG behavior (especially environmental infringements) by issuers and not penalize them. Therefore, we estimate the difference in yield-to-maturity (YTM) at issuance between a green bond and a counterfactual

Panel A. CARs around ESG incidents for green and matched conventional bonds

Fig. 3a. CARs around the ESG incident for the matched sample. The figures report the differences in cumulative abnormal returns for green and matched conventional bonds around the ESG incident for the PSM sample (i.e., 662 bond-incident pairs) in the time window [-20, +20]. Panel A reports the trend in CARs for treated (green) and control (conventional) bonds around the incident, where, as before, we first consider the entire sample of incidents and then condition on the type of incident (environmental vs non-environmental). Instead, Panel B reports the magnitude of the T-statistics of the daily treated-conventional CARs differences in the same time window.

conventional bond for both the initial and PSM samples.

Panel A of Table 10 reports difference-in-means statistics testing the existence of a *greenium* at bond issuance. For a given issuer, there is no noticeable difference between the yields at issue of green and conventional bonds in any of the samples tested. Consistent with our main results, the average YTM difference is small in economic terms and statistically insignificant. This result is also in line with the findings of Larcker and Watts (2020) and Flammer (2021), who show the nonexistence of a *greenium* in the municipal and corporate bond markets, respectively. In Panel B, we condition on the location of the issuer to test whether there were differences between bonds issued by firms located in North America, Asia, and Europe, and again find no statistically significant results. Instead, in Panel C, we condition on green bond features, i.e., the alignment with CBI standards, the presence of a second party opinion, and

Panel B. T-statistics for green and matched conventional bonds' differences around the ESG incident

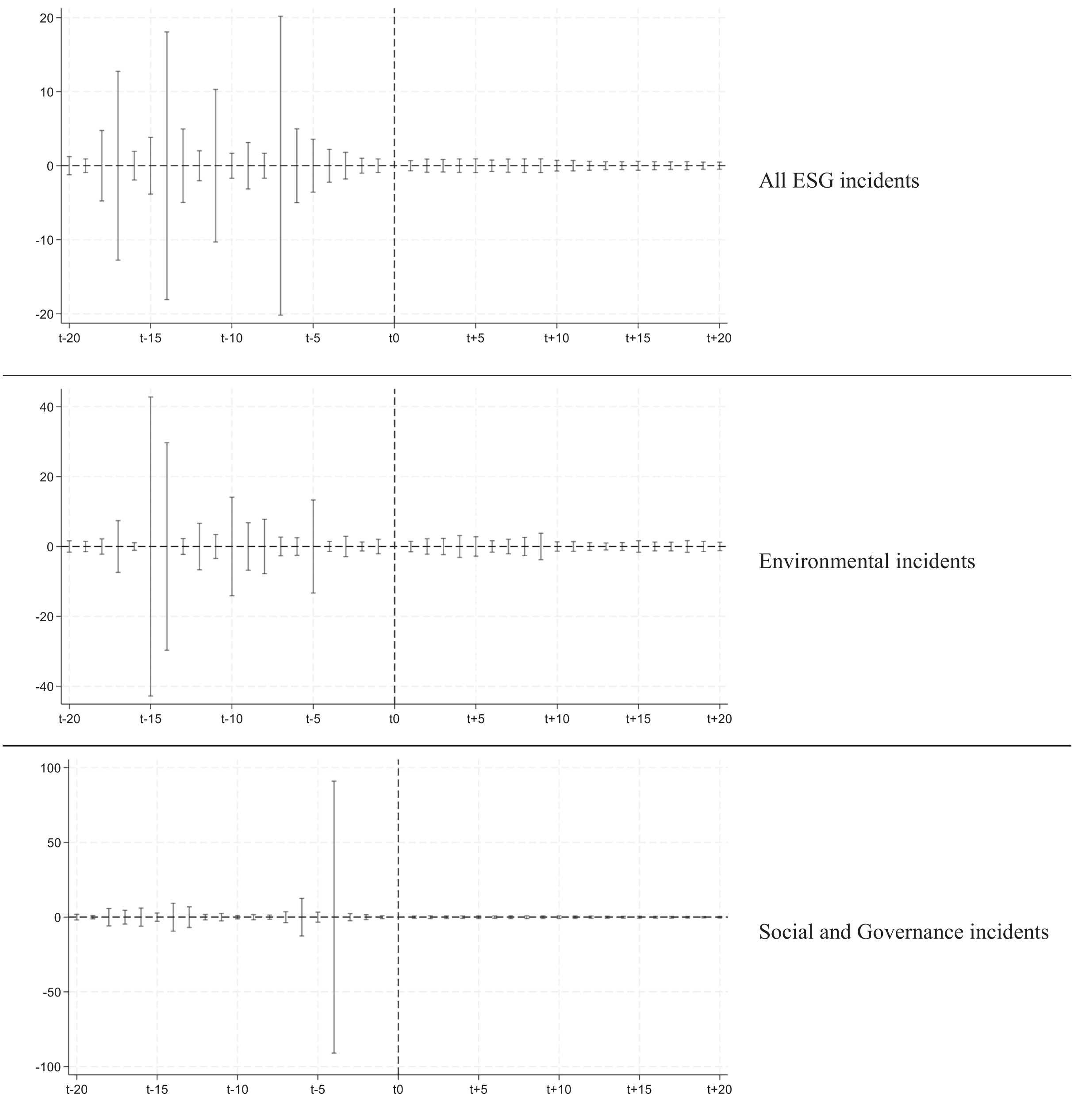

Fig. 3b. CARs around the ESG incident for the matched sample *(continued)*.

whether that green bond represents a first-time issuance for the firm. Except for the case of alignment with CBI standards, we find no evidence of a *greenium* at issuance.

Beyond investor preferences for the green factor, addressing liquidity concerns is crucial, since it is a well-documented risk factor affecting bond value. A well-known feature of corporate bonds is their illiquidity, and a natural question is whether investors in corporate green bonds experience the same problem. Existing evidence suggests that green bonds often have lower liquidity than conventional bonds (Boutabba and Rannou, 2022; Su and Lin, 2022). Therefore, a substantial difference in liquidity between the two categories of bonds may play a notable role in explaining differences in their post-incident performance. To this end, we assess differences in liquidity using two complementary proxies, namely the *zeros* measure (i.e., the percentage of trading days with zero returns in a given period) and the quoted *bid-ask spread*, which is one of the most widely used indicators of bond illiquidity (Lesmond et al., 1999; Longstaff et al., 2005; Chen et al., 2007). The results of difference-in-means tests for illiquidity between the two categories of

Table 8

DiD regressions estimating the impact of ESG incidents. PSM sample. We report estimation results for the DiD regressions estimating the impact of ESG incidents on the bond price performance of green bonds relative to similar conventional bonds selected by applying 1:1 nearest-neighbor matching. The dependent variable is the CAR computed from day −20 (i.e., 20 days before the event occurrence). Estimates are based on a [-20, +20] window.

Dependent variable CAR[-20,*n*]	(1)	(2)	(3)	(4)
GreenBond	0.000	0.008	−0.039	−0.055
	(0.036)	(0.035)	(0.035)	(0.034)
After	−0.172***	−0.157***	−0.175***	−0.218***
	(0.052)	(0.048)	(0.047)	(0.046)
GreenBond*After	0.226***	0.219***	0.222***	0.225***
	(0.072)	(0.067)	(0.066)	(0.064)
Ln(amount issued)			0.004	0.009
			(0.015)	(0.015)
Modified duration			−0.043***	−0.058***
			(0.009)	(0.009)
Ln(asset)			−0.104	−0.089
			(0.089)	(0.537)
Profitability			4.306***	−1.219
			(0.968)	(1.291)
Leverage			7.552***	36.131***
			(0.596)	(2.350)
Market-to-book			−0.036***	0.000
			(0.006)	(0.007)
ENV pillar			0.046***	−0.175***
			(0.005)	(0.019)
SOC pillar			−0.049***	0.025**
			(0.004)	(0.011)
GOV pillar			−0.004**	0.097***
			(0.002)	(0.004)
Constant	−0.249***	0.853*	0.386	7.344
	(0.025)	(0.459)	(0.844)	(7.873)
Incident Year	No	No	Yes	Yes
Seniority	No	No	Yes	Yes
Currency	No	No	Yes	Yes
Coupon type	No	No	Yes	Yes
Domicile	No	No	Yes	No
Industry	No	No	Yes	No
Issuer	No	No	No	Yes
Observations	26,483	26,483	26,483	26,483
R-squared	0.001	0.144	0.160	0.211

Notes: robust standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

bonds are reported in Table 11, where the two proxies are computed on the daily trading days in the year before the event announcement date. For the full sample, these results suggest that there is no sizeable difference between green and conventional bonds' liquidity. When conditioning on issuers' location, the only noteworthy difference emerges for Europe, where green bonds surprisingly exhibit higher liquidity than matched conventional bonds (albeit only in the case of the *bid-ask spread*, while we continue to observe an insignificant difference when considering the *zeros* measure). Finally, a similar result is observed when conditioning on green bond certification. Specifically, the above result is confirmed when uniquely considering CBI-aligned green bonds (for both the *bid-ask spread* and the *zeros* measure), while the presence of a second party opinion and the fact that the green bond represents a first-time issuance by the issuer do not matter.

Next, in Table 12, we run our primary DiD regression after conditioning on the geographical region where the bond issuer is headquartered. Interestingly, the results show no significant effect in Europe, while in North America and Asia, green bonds outperform their conventional counterparts in the post-incident window. This evidence is consistent with the different levels of liquidity across countries observed in Table 11. In particular, we find that when the green bond market is more liquid, as in the case of Europe, there are no significant differences in post-incident performance between the two bonds, likely because there are no additional transaction costs.

Similarly, in Table 13, we show the results of our primary DiD regression to determine whether the presence of green certification matters for the post-incident performance differences between green and conventional bonds. After conditioning on the presence of a green bond's CBI-taxonomy alignment, we find that the post-incident green bonds' performance is worse relative to the conventional bonds. This evidence suggests that CBI-aligned green bonds, for which investors are also willing to forgo part of the return to ensure that the proceeds are used in an environmentally sustainable manner (as shown in Table 10), may create higher expectations in the market and consequently be penalized more in case of an ESG incident. CBI-aligned green bonds are the only case for which we find this result, while none of the previous results change when performing a similar analysis for first-time green bond issues and green bonds holding a second party opinion: not surprisingly, in the latter two cases we observe neither a *greenium* at issuance nor significant

Table 9

DiD regressions conditioning upon incident characteristics. In this table, we report DiD estimation results for the PSM sample after conditioning on the type of incident. We separate environmental incidents (columns 1 to 3) from social and/or governance-related incidents (columns 4 to 6), and for both categories we further condition on incidents' severity and reach. The dependent variable is the daily CAR computed from day −20 (i.e., 20 days before the event occurrence). Estimates are based on a [-20, +20] window.

	Environmental incidents			Social and governance incidents		
Dependent variable CAR[-20,*n*]	All	Higher severity	Higher reach	All	Higher severity	Higher reach
	(1)	(2)	(3)	(4)	(5)	(6)
GreenBond	−0.058	−0.102	−0.143	−0.039	−0.278	−0.064
	(0.068)	(0.136)	(0.089)	(0.038)	(0.173)	(0.048)
After	−0.958***	0.223	−0.726***	0.045	−0.198**	−0.110*
	(0.084)	(0.165)	(0.108)	(0.047)	(0.086)	(0.059)
GreenBond*After	0.144	−0.192	0.464***	0.259***	0.041	0.326***
	(0.116)	(0.234)	(0.133)	(0.066)	(0.110)	(0.082)
Ln(amount issued)	−0.044	−0.106**	0.110***	0.074***	−0.100***	0.065***
	(0.032)	(0.042)	(0.030)	(0.016)	(0.026)	(0.019)
Modified duration	−0.138***	−0.011	−0.135***	0.019**	−0.006	0.044***
	(0.013)	(0.026)	(0.015)	(0.009)	(0.015)	(0.011)
Ln(asset)	11.259***	4.283***	79.188***	−2.899**	109.788***	9.242***
	(1.894)	(1.011)	(5.210)	(1.343)	(12.369)	(1.527)
Profitability	−37.447***	−19.151	−82.794***	11.148***	−58.973***	−28.557***
	(6.421)	(15.902)	(3.860)	(2.635)	(6.424)	(8.710)
Leverage	49.230***	27.481***	359.786***	50.764***	−10.121***	66.170***
	(7.570)	(6.416)	(24.041)	(3.110)	(0.128)	(3.718)
Market-to-book	−0.061	0.176	0.285*	−0.146***	5.545***	0.081**
	(0.170)	(0.115)	(0.167)	(0.011)	(0.650)	(0.035)
ENV pillar	−0.373***	0.045**	−8.243***	−0.059**	8.085***	0.076
	(0.047)	(0.023)	(0.504)	(0.028)	(0.869)	(0.048)
SOC pillar	0.012	−0.132***	5.066***	0.033*	−3.708***	0.074**
	(0.035)	(0.045)	(0.327)	(0.018)	(0.433)	(0.036)
GOV pillar	0.172***	−0.071***	0.285***	0.111***	1.135***	0.143***
	(0.028)	(0.015)	(0.024)	(0.005)	(0.119)	(0.008)
Constant	−13.535***	−64.840***	−10.845***	35.004*	−18.267***	−14.120***
	(2.578)	(16.703)	(0.777)	(18.250)	(1.954)	(2.207)
Incident Year	Yes	Yes	Yes	Yes	Yes	Yes
Seniority	Yes	Yes	Yes	Yes	Yes	Yes
Currency	Yes	Yes	Yes	Yes	Yes	Yes
Coupon type	Yes	Yes	Yes	Yes	Yes	Yes
Observations	8,566	2,250	3,684	17,917	3,626	11,445
R-squared	0.312	0.314	0.491	0.353	0.538	0.348

Notes: robust standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

differences in bond liquidity, in contrast to CBI-aligned green bonds. This provides further confirmation of the cost-effectiveness argument embedded in our Hypothesis 2.

4.4. Additional evidence

In this section, we propose additional evidence to validate the role of heterogeneity in liquidity patterns in driving our main result based on credit default swaps (CDSs). Although illiquidity is important in the pricing of corporate bonds, the relative evidence for conventional bonds is mostly qualitative, indirect and still lacking for the green bonds. Indeed, because liquidity is very poor in secondary bond markets, most material signals are traded in CDS markets. For example, Bao et al., (2011) find a strong link between credit and liquidity risks at the issuer level. Longstaff et al. (2005) suggest that most bond spreads can be attributed to credit risk and the non-default component to bond-specific illiquidity.

Therefore, in Table 14, we first estimate whether the existence of an actively traded CDS having the bond issuer as reference entity contributes to explaining the observed impact of ESG incidents on green and conventional bond returns. Overall, consistent with our previous results, the performance of conventional bonds is always worse than that of the corresponding green bonds in the case of social and governance related incidents and high media impact incidents.

Secondly, in Table 15, limited to the part of the 1:1 matched sample having an actively traded CDS, we re-estimate our main DiD regressions after interacting our *GreenBond*After* dummies with *CDSliquidity*, taking the value of 1 if the liquidity of the CDS (measured by the *zeros*) having bond issuer as the reference entity is higher than the sample median and zero otherwise. The goal is to observe whether the liquidity of the CDS market contributes to explaining the effect of ESG incidents on bond performance. Again, our results are confirmed in the case of environmental and high media impact incidents, suggesting that when investors have a liquid CDS market to hedge, they dump the risk on the CDS instead of disinvesting from the green bond.

In addition, since we use a large international sample, in this section we test whether our results might depend on country-specific factors that might ultimately lead investors to perceive the ESG incident differently. Hence, we focus on cross-country differences in

Table 10
Testing the existence of a green premium at issuance. The table reports difference-in-means statistics estimating the existence of a green premium (i.e., *greenium*) at bond issuance. Panel A reports the YTM at issuance for green and conventional bonds and their respective differences. We estimate the YTM at issuance on both the initial sample (before 1:1 matching) and the PSM sample. In Panel B, we report the estimates of the existence of a green premium controlling for the location of the issuer. In Panel C, we report the same estimates after conditioning on green bond characteristics, and in particular on the alignment with CBI standards, the presence of a second party opinion, and whether the green bond represents a first-time ever issuance for the firm. Thus, we repeat the estimates from Panel A after excluding bonds with such characteristics from the green bond group. Columns 1 and 2 report the average values (in YTM and bond liquidity) for green and conventional bonds, respectively. Column 3 reports the differences in means, while columns 4 and 5 report the t-statistics and p-values of such differences.

Panel A. Green premium at issuance					
	Green Bonds	Conventional Bonds	Difference	T-stat	P-value
	(1)	(2)	(3)	(4)	(5)
YTM – pre-match sample	0.0202	0.0194	0.0008	0.5496	0.5825
YTM – post-match sample	0.0172	0.0193	−0.0021	−1.4826	0.1391
Panel B. Green premium by issuer's location – post-match sample					
	Green Bonds	Conventional Bonds	Difference	T-stat	P-value
	(1)	(2)	(3)	(4)	(5)
YTM – North America	0.0233	0.0240	−0.0006	−0.2091	0.8351
YTM – Asia	0.0165	0.0192	−0.0027	−1.5069	0.1333
YTM – Europe	0.0151	0.0154	−0.0003	−0.0895	0.9290
Panel C. Addressing green bonds' specific features – post-match sample					
	Green Bonds	Conventional Bonds	Difference	T-stat	P-value
	(1)	(2)	(3)	(4)	(5)
YTM – CBI aligned	0.0143	0.0193	−0.0050	−3.2325	0.0014
YTM – second party opinion	0.0174	0.0193	−0.0019	−1.2126	0.2262
YTM – 1st time issuance	0.0161	0.0193	−0.0026	−1.5420	0.1242

Table 11
Testing liquidity differences between green and conventional bonds. In this table, we report difference-in-means statistics on liquidity differences between green and conventional bonds. All estimates refer to the PSM sample. The two bond liquidity proxies are the zeros (i.e., the percentage of trading days with zero returns in a given period of time) and the quoted bid-ask spread. Both measures are computed based on trading days from the year prior to the ESG incident (i.e., the [-365, 0] window). We calculate our liquidity measures both for the full 1:1 matched sample and by issuer location (North America, Asia, and Europe). Columns 1 and 2 report the average values for zeros and bid-ask spread for green and conventional bonds, respectively. Column 3 reports differences in means, while columns 4 and 5 report the t-statistics and p-values of these differences. We also test liquidity differences between green and conventional bonds, conditioning on issuers' location and green bond features.

	Green Bonds	Conventional Bonds	Difference	T-stat	P-value
	(1)	(2)	(3)	(4)	(5)
Full sample					
Bid-Ask [-365, 0]	0.4462	0.3792	0.0670	2.2247	0.0022
Zeros [-365, 0]	0.0153	0.0174	−0.0022	−0.7077	0.4793
By issuer's location					
Bid-Ask [-365, 0] – North America	0.3799	0.3666	0.0133	0.2280	0.8201
Bid-Ask [-365, 0] – Asia	0.4731	0.4774	−0.0044	−0.1310	0.8959
Bid-Ask [-365, 0] – Europe	0.3234	0.4150	−0.0915	−2.8161	0.0057
Zeros [-365, 0] – North America	0.0132	0.0159	−0.0027	−0.9004	0.3698
Zeros [-365, 0] – Asia	0.0214	0.0166	0.0048	0.8278	0.4085
Zeros [-365, 0] – Europe	0.0098	0.0233	−0.0134	−1.4094	0.1609
By green bond features					
Bid-Ask [-365, 0] – CBI aligned	0.3645	0.4079	−0.0434	−1.9251	0.0550
Bid-Ask [-365, 0] – second party opinion	0.4402	0.4446	−0.0045	−0.1552	0.8767
Bid-Ask [-365, 0] – 1st time issuance	0.3868	0.4201	−0.0333	−1.1678	0.2437
Zeros [-365, 0] – CBI aligned	0.0131	0.0206	−0.0074	−1.9244	0.0550
Zeros [-365, 0] – second party opinion	0.0137	0.0150	−0.0013	−0.2434	0.8078
Zeros [-365, 0] – 1st time issuance	0.0159	0.0202	−0.0043	−0.8511	0.3953

Table 12

ESG incidents and cumulative abnormal returns. Cross-country evidence. In the table, we report the results for our main DiD regression after dividing the full PSM sample by the geographic region where the bond issuer is headquartered. The dependent variable is the daily CAR computed from day −20 (i.e., 20 days before the event occurrence). Estimations are based on a [-20, +20] window.

Dependent variable CAR[-20,*n*]	North America (1)	Asia (2)	Europe (3)
GreenBond	0.025	−0.143	0.252***
	(0.036)	(0.099)	(0.091)
After	−0.069	−0.400***	−0.240**
	(0.045)	(0.065)	(0.098)
GreenBond*After	0.189***	0.263***	0.090
	(0.062)	(0.092)	(0.137)
Ln(amount issued)	0.032*	0.064**	0.161***
	(0.019)	(0.026)	(0.042)
Modified duration	0.016*	−0.071***	0.030**
	(0.009)	(0.012)	(0.013)
Ln(asset)	−1.764***	−0.020	26.203***
	(0.409)	(2.705)	(1.386)
Profitability	11.423***	–32.540***	42.991***
	(3.468)	(4.591)	(1.730)
Leverage	16.600***	1.842	54.418***
	(3.722)	(5.418)	(10.582)
Market-to-book	−0.085***	−1.158***	0.050
	(0.014)	(0.160)	(0.212)
ENV pillar	0.053**	0.137***	0.153***
	(0.022)	(0.033)	(0.040)
SOC pillar	−0.007	−0.047	0.394
	(0.019)	(0.036)	(0.262)
GOV pillar	0.028***	0.093***	0.203***
	(0.007)	(0.015)	(0.013)
Constant	16.248**	−13.644	−328.417***
	(6.770)	(33.241)	(25.127)
Incident Year	Yes	Yes	Yes
Seniority	Yes	Yes	Yes
Currency	Yes	Yes	Yes
Coupon type	Yes	Yes	Yes
Observations	5,240	16,639	4,084
R-squared	0.179	0.194	0.474

Notes: robust standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

the stringency of green legislation, which might affect the post-incident performance of green and conventional bonds differently. We therefore compare the stringency of environmental policies across countries by using the OECD Environmental Policy Stringency (EPS) index, a widely used tool for policy analysis (Botta and Koźluk, 2014). The OECD EPS is a composite index[13] that has been used extensively in empirical studies to assess the cross-country impact of stricter environmental policies on environmental and economic outcomes. Specifically, we make use of the Market Based Instruments (MBI) sub-index, representing a component of the EPS index and grouping policies that put a price on pollution. Accordingly, we define an indicator variable, *EPSmarket*, taking the value of 1 if the MBI index is above the sample median (stricter regulations) and zero in the opposite case.

In this case, the interaction term *GreenBond*After*EPSmarket* in Table 16 is positive and statistically significant, again supporting our Hypothesis 2. Thus, we observe that in countries where the cost of polluting is higher, conventional bonds underperform green bonds after the incident but only in the case of environmental incidents and high media impact. No significant effect is detected in the other cases.

5. Discussion and conclusions

Green bonds have been developed as a new way to finance green projects. They are currently one of the financial market tools with the potential to contribute to the financing of clean energy and climate change solutions. While the issuance of green bonds has more limitations due to the restrictions on the use of proceeds in environmentally friendly projects, previous literature has noted that they may allow the issuer to obtain cheaper financing than conventional bonds. However, compared to conventional bonds, there may be a risk of greenwashing. Therefore, there is still an ongoing debate about the credibility of green bonds and their ability to raise capital for climate change mitigation and adaptation.

[13] The revised version of the EPS (“EPS21”) includes three sub-indexes, namely: the Market Based Instruments (MBI) sub-index, including policies that put a price on pollution; the Non-Market Based Instruments (NMBI) sub-index, that entails policies imposing emission limits and standards and the Technology Support (TS) policies sub-index, that entails policies that support innovation in clean technologies and their adoption.

Table 13
Effect of ESG incidents on CARs. The relevance of Green Bond certification. We report the same estimations as in Table 11, but we further interact our GreenBond and After dummies with CBIaligned, which takes the value of 1 for matched pairs where the green bond is aligned with the Climate Bond Initiative taxonomy, and zero otherwise. Our goal is to observe whether the presence of green certification matters for post-incident performance differences between green and conventional bonds. The dependent variable is the daily CAR computed from day −20 (i.e., 20 days before the event occurrence). Estimations are based on a [-20, +20] window.

Dependent variable CAR[-20,*n*]	Full matched sample	Environmental incidents	Social and governance incidents	Higher reach incidents
	(1)	(2)	(3)	(4)
GreenBond	0.095	0.261	−0.031	0.034
	(0.070)	(0.166)	(0.081)	(0.089)
After	−0.671***	−2.545***	0.407***	−0.455***
	(0.100)	(0.162)	(0.094)	(0.126)
CBIaligned	−0.694***	−1.441***	−0.875***	−0.894***
	(0.064)	(0.146)	(0.076)	(0.083)
GreenBond*After	0.435***	0.698***	0.291*	0.825***
	(0.150)	(0.226)	(0.156)	(0.196)
GreenBond*CBIaligned	−0.247***	−0.543***	−0.009	−0.145
	(0.081)	(0.153)	(0.092)	(0.101)
After*CBIaligned	0.708***	2.617***	−0.397***	0.438***
	(0.115)	(0.192)	(0.114)	(0.144)
GreenBond*After*CBIaligned	−0.298*	−0.820***	−0.049	−0.621***
	(0.168)	(0.268)	(0.179)	(0.216)
Bond-level controls	Yes	Yes	Yes	Yes
Issuer-level controls	Yes	Yes	Yes	Yes
Fixed effects				
Incident Year	Yes	Yes	Yes	Yes
Seniority	Yes	Yes	Yes	Yes
Currency	Yes	Yes	Yes	Yes
Coupon type	Yes	Yes	Yes	Yes
Observations	26,483	8,566	17,917	15,129
R-squared	0.075	0.234	0.125	0.093

Notes: robust standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 14
ESG incidents, CARs and CDS availability. We estimate whether the existence of an actively traded CDS on the issuer helps explain the observed impact of ESG incidents on green and conventional bond returns. To do so, we further interact our *GreenBond* and *After* dummies with *CDS*, which takes the value of 1 for issuers for which a CDS exists and zero otherwise. The dependent variable is the daily CAR computed from day −20 (i.e., 20 days before the event occurrence). Estimations are based on a [-20, +20] window.

Dependent variable CAR[-20,*n*]	Full matched sample	Environmental incidents	Social and governance incidents	Higher reach incidents
	(1)	(2)	(3)	(4)
GreenBond	−0.086*	−0.156*	−0.034	−0.104**
	(0.045)	(0.089)	(0.051)	(0.052)
After	0.170***	−0.040	0.217***	0.095*
	(0.052)	(0.126)	(0.055)	(0.056)
CDS	10.299***	−14.213***	16.008***	−14.359***
	(1.464)	(3.083)	(2.796)	(1.880)
GreenBond*After	0.107	0.046	0.126	0.095
	(0.076)	(0.167)	(0.084)	(0.086)
GreenBond*CDS	0.081	0.160	0.041	0.051
	(0.067)	(0.124)	(0.076)	(0.081)
After*CDS	−0.693***	−1.274***	−0.350***	−0.584***
	(0.088)	(0.165)	(0.095)	(0.106)
GreenBond*After*CDS	0.212*	0.136	0.273**	0.510***
	(0.124)	(0.224)	(0.134)	(0.146)
Bond-level controls	Yes	Yes	Yes	Yes
Issuer-level controls	Yes	Yes	Yes	Yes
Fixed effects				
Incident Year	Yes	Yes	Yes	Yes
Seniority	Yes	Yes	Yes	Yes
Currency	Yes	Yes	Yes	Yes
Coupon type	Yes	Yes	Yes	Yes
Observations	26,483	8,566	17,917	15,129
R-squared	0.206	0.314	0.344	0.281

Notes: robust standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 15

ESG incidents, CARs and CDS liquidity. In this table, we estimate our main DiD regressions after further interacting our *GreenBond* and *After* dummies with *CDSliquidity*, which takes the value of 1 if the liquidity of the CDS (having bond issuer as the reference entity) is higher than the sample median and zero otherwise. So, the estimations are limited to the part of 1:1 matched sample having an actively traded CDS. The goal is to observe whether the liquidity in the CDS market contributes to explaining the effect of incidents on bond performance. The dependent variable is the daily CAR computed from day −20 (i.e., 20 days before the event occurrence). Estimations are based on a [-20, +20] window.

Dependent variable CAR[-20,*n*]	Full matched sample	Environmental incidents	Social and governance incidents	Higher reach incidents
	(1)	(2)	(3)	(4)
GreenBond	−0.060	0.008	0.042	0.025
	(0.073)	(0.111)	(0.081)	(0.083)
After	−0.586***	−0.224*	−0.850***	−0.913***
	(0.090)	(0.122)	(0.114)	(0.114)
CDSliquidity	0.846***	0.564***	0.318***	0.132
	(0.089)	(0.195)	(0.103)	(0.115)
GreenBond*After	0.182	−0.228	0.448***	0.403***
	(0.123)	(0.176)	(0.151)	(0.148)
GreenBond*CDSliquidity	0.147	0.033	0.112	0.036
	(0.103)	(0.170)	(0.118)	(0.122)
After*CDSliquidity	0.242*	−2.367***	1.738***	1.144***
	(0.144)	(0.203)	(0.154)	(0.183)
GreenBond*After*CDSliquidity	0.270	0.798***	−0.088	0.467*
	(0.199)	(0.284)	(0.214)	(0.245)
Bond-level controls	Yes	Yes	Yes	Yes
Issuer-level controls	Yes	Yes	Yes	Yes
Fixed effects				
Incident Year	Yes	Yes	Yes	Yes
Seniority	Yes	Yes	Yes	Yes
Currency	Yes	Yes	Yes	Yes
Coupon type	Yes	Yes	Yes	Yes
Observations	14,967	6,122	8,845	8,261
R-squared	0.085	0.338	0.279	0.177

Notes: robust standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

Table 16

Effect of ESG incidents on CARs. Addressing country-level environmental legislation. In this table, we estimate the potential role of cross-country green legislation severity in shaping the post-incident performance differences between green and conventional bonds. We measure green legislation severity by using the Environmental Policy Stringency (EPS) index, which measures the extent of country regulations in penalizing/preventing environmentally harmful behaviors and/or in promoting the adoption of green technologies. Specifically, we take the Market-Based Instruments (MBI) index, which is a component of the EPS index based on those policies that put a price on pollution and ranges from 0 to 6, with higher values indicating a higher degree of policy stringency. Accordingly, we define an indicator variable, *EPSmarket*, which takes the value of 1 if the MBI index is above the sample median (stricter regulations) and zero otherwise. The dependent variable is the daily CAR computed from day −20 (i.e., 20 days before the event occurrence). Estimations are based on a [-20, +20] window.

Dependent variable CAR[-20,*n*]	Full matched sample	Environmental incidents	Social and governance incidents	Higher reach incidents
	(1)	(2)	(3)	(4)
GreenBond	−0.199***	−0.216**	−0.102**	−0.102**
	(0.045)	(0.095)	(0.048)	(0.048)
After	−0.021	0.288**	−0.164**	−0.164**
	(0.061)	(0.114)	(0.071)	(0.071)
EPSmarket	0.366***	1.048***	−0.089	−0.089
	(0.072)	(0.137)	(0.091)	(0.091)
GreenBond*After	0.140*	−0.098	0.245**	0.245**
	(0.083)	(0.157)	(0.096)	(0.096)
GreenBond*EPSmarket	0.317***	0.282*	0.153*	0.153*
	(0.074)	(0.146)	(0.083)	(0.083)
After*EPSmarket	−0.353***	−2.347***	0.726***	0.726***
	(0.104)	(0.178)	(0.112)	(0.112)
GreenBond*After*EPSmarket	0.189	0.541**	0.040	0.040
	(0.147)	(0.248)	(0.161)	(0.161)
Bond-level controls	Yes	Yes	Yes	Yes
Issuer-level controls	Yes	Yes	Yes	Yes
Fixed effects				
Incident Year	Yes	Yes	Yes	Yes
Seniority	Yes	Yes	Yes	Yes
Currency	Yes	Yes	Yes	Yes
Coupon type	Yes	Yes	Yes	Yes
Observations	26,483	8,566	17,917	17,917
R-squared	0.071	0.228	0.112	0.112

Notes: robust standard errors are reported in parentheses. *, **, *** indicate statistical significance at the 10%, 5% and 1% levels, respectively.

This study extends the existing literature by examining the corporate bond market reaction to ESG incidents involving the issuer. In particular, we compare the CARs of both green and conventional bonds after the ESG incidents and find that the market mechanism of "punishing" those socially irresponsible companies whose actions are in contrast to the signal sent through the green bond issue is not *a priori* obvious. Our analysis yields interesting findings.

First, the event study results show that both types of bonds experienced a decline in performance following the ESG incident, but the decline was more pronounced for conventional bonds. Second, we repeat our estimations after applying 1:1 propensity score matching to address potential endogeneity concerns. The main results hold except for environmental incidents, where conventional bonds underperform green bonds only for incidents with higher media impact. Third, we investigate whether pecuniary factors, such as the cost-effectiveness of bonds − both in terms of a *greenium* at issuance and bond liquidity − may act as a mechanism driving the performance differences between green and conventional bonds. Specifically, we find that green bonds were not issued at a premium and, more importantly, that conventional bonds are on average slightly more liquid than paired green bonds. Our evidence suggests that while illiquidity is generally viewed as a disadvantage, it can act as a stabilizing force during periods of market distress, such as an ESG incident involving the issuers. The lower liquidity of green bonds relative to their conventional counterparts may discourage sharp sell-offs, thereby mitigating the decline in the performance of green bonds relative to their counterparts.

Finally, our findings also highlight differences in the post-incident performance of green and conventional bonds depending on the geographical region where the bond issuer is headquartered and on the characteristics of the green bond, such as the presence of a second party opinion. In particular, we find no significant differences in post-incident performance between the two bonds in a more liquid green bond market, such as the case of Europe. Consequently, our results suggest that when investors do not incur additional transaction costs to liquidate green bonds, the performance decline is not significantly different from that of conventional bonds. Moreover, green bonds with a second party opinion underperform their conventional counterparts. This evidence is in line with what we find in the case of green bonds with a second party opinion, where investors are willing to forgo returns to ensure that the proceeds are used in an environmentally sustainable manner (i.e., the existence of a *greenium*). This higher commitment is likely to raise market expectations, leading to greater penalties in the event of negative ESG news.

The results presented in this study offer new insights to the existing literature on green bonds and sustainable finance and have important implications, especially for issuers, investors, and policymakers. In this regard, our evidence shows that, due to the financial characteristics of green bonds and their market, issuers may benefit from issuing green bonds, especially when an ESG incident occurs. Accordingly, when a firm suffers a reputational shock, prior investments in CSR i.e., issuing a green bond, might protect the firm from such a shock. Therefore, alongside the benefits highlighted in the previous literature in terms of an improved ESG profile or lower cost of capital, we pointed out the potential advantages of green bond issuance in times of market turbulence. Our results might also be relevant for investors, as they suggest the risk-reducing potential of green investments, especially in turbulent market periods, thus confirming the resilience factor highlighted in previous studies (Yousaf et al., 2022). Moreover, this study may also have implications for financial regulators. Indeed, policymakers should consider that our findings suggest the absence of an effective market-based mechanism that "punishes" those companies whose CSI actions are in contrast with the signal given through the green bond.

This study has some limitations that call for future research. First, our analysis only compares the performance of green bonds with that of traditional bonds issued by the same firm. As a possible future direction of analysis, this study could also be extended to other types of bonds, such as social and/or sustainability-linked bonds, to analyze the impact of ESG incidents on investors' pro-social and pro-sustainability preferences. In this vein, future developments may provide comparisons not only between sustainable and conventional bonds, but also between different categories of sustainable bonds, namely green, social, and sustainability bonds, to explore possible reactions in relation to the types of ESG incidents. Second, although the RepRisk measure is widely used and accepted in the literature, future research could also explore the use of an alternative measure of ESG incidents. Third, our paper does not control for investor variation. Although green bond holders are primarily institutional investors, the latter may have different motivations for choosing green bond investments than retail investors, which may lead to different reactions to ESG incidents.

Finally, our empirical investigation is limited to the corporate bond market reaction. Since previous literature has pointed to differences, especially in green bond pricing, due to issuer type (Fatica et al., 2021; Hachenberg and Schiereck, 2018), future research could provide more evidence by observing different issuers, such as public institutions and governments.

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CRediT authorship contribution statement

Matteo Cotugno: Writing – review & editing, Supervision, Funding acquisition, Conceptualization. **Paolo Fiorillo:** Writing – review & editing, Writing – original draft, Methodology, Formal analysis, Data curation. **Stefano Monferrà:** Supervision. **Sabrina Severini:** Writing – review & editing, Writing – original draft, Validation.

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.

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Author statement

All authors have equally contributed to the development of this paper.

Data availability

Data will be made available on request.

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