When green is no longer a win - new evidence on the shareholder wealth effects of green bond issuance[1]

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Abstract

We uncover a decreasing trend in stock price reactions to corporate green bond offering announcements between January 2013 and June 2021. Further analysis suggests this finding can be jointly attributed to two major environmental shocks, i.e. the US Paris Agreement withdrawal and the global outbreak of COVID-19, and to shifts in green bond issuer characteristics. We furthermore obtain novel evidence on the determinants of stock price reactions around green bond announcements, with cross-sectional results indicating that abnormal stock returns of green bond issuers are negatively influenced by issuers' proprietary costs, and positively influenced by issuers' reputational gains from being seen as green, focus on innovation, and debt capacity. We do not find a significant time trend, nor similar announcement return determinants for a placebo dataset of corporate non-green bonds. Our results withstand a range of robustness tests, including a test addressing sample selection bias. Overall, our paper provides a more nuanced, less optimistic view on the shareholder value impact of green bond announcements, compared with the very favorable results of the few prior studies on green bond announcement returns.

Keywords: Green bonds, corporate social responsibility, environmental social and governance (ESG), event study, shareholder value, sustainability

JEL: G19, G30, M14

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1. Introduction

A green bond differs from a conventional bond by being "labelled", i.e. designated as "green" by the issuer or another entity, whereby a commitment is made to use the green bond proceeds in a transparent manner, and exclusively to finance or refinance green projects, assets, or business activities with an environmental benefit (OECD, 2015). According to the Climate Bonds Initiative (CBI), total global green bond proceeds reached 297 billion USD in 2021 and are estimated to be at 450 billion USD in 2022 (CBI, 2021). In response to the growing popularity of green bonds, a rapidly expanding body of academic research has examined green bond yields relative to conventional bond yields (Karpf and Mandel, 2017; Gianfrate and Peri, 2019; Nanayakkara and Colombage, 2019; Zerbib, 2019; Larcker and Watts, 2020; Baker et al., 2021; Kapraun et al., 2021; MacAskill et al., 2021), and the diversification and hedging benefits of green bonds in investment portfolios (Jun et al., 2020; Nguyen et al., 2021; Yousaf et al., 2021). Other studies examine the determinants of issuers' choice between green and conventional bonds (Dutordoir et al., 2022), and whether and how green bonds affect corporate post-issuance performance (Fatica and Panzica, 2021; Flammer, 2021; Sangiorgi and Schopohl, 2021).

In this paper, we study green bonds from a shareholder perspective. Two relevant previous studies have shown a positive stock price reaction to green bond announcements. More particularly, using an international sample of 665 green bonds issued between June 2007 and December 2017, Tang and Zhang (2020) find a positive abnormal stock return around corporate green bond announcements over the window [−10, 10] relative to the announcement date. Using an international sample of 384 corporate green bonds issued between January 1, 2013,

and December 31, 2018, Flammer (2021) documents a positive stock price reaction to corporate green bond announcements over window [−5, 10]. Both studies find more positive reactions to first-time green bond issues, compared with follow-on green bond offerings.

Our study is inspired by two gaps in these previous studies. Firstly, these studies focus on a sample period spanning the first few years after the initial corporate green bond issued in 2012. Following this initial honeymoon period, the corporate green bond market has been maturing and has become increasingly crowded, with an exponential increase in the number of offerings. As Blanco et al. (2020) note, the profitability of green projects is not static over time. Intuitively, green bond issuers will implement the most economically attractive green projects first. Therefore, the "low-hanging fruits" (i.e. the most profitable green projects) may already be financed by the early green bond issues, and the net present value of the remaining green opportunities left for the pool of potential green bond issuers may be lower. Moreover, investor opinions about green bond issuance may also have shifted over time, due to changes in overall opinions about the desirability of environmentally favorable activities (Flammer, 2013). Finally, green bond issuer characteristics may have changed over time, leading to a different shareholder perception on the incremental cash flow effects of green bond offerings. Little is known about whether the stock price reaction to corporate green bond announcements is still positive over recent years, and how green bond announcements returns are evolving over time. Our study addresses this question. Secondly, previous studies do not systematically examine determinants of stock price reactions to green bond announcements, probably because until recently there were simply too few corporate green bond issuers with sufficient relevant firm-specific characteristics available to execute a meaningful cross-sectional analysis (Dutordoir et

al., 2022). Our main goal in this paper is, therefore, twofold: to re-visit the sign of stock price reactions to green bond announcements, and to provide the first in-depth analysis of determinants of cross-sectional differences in these announcement effects.

To examine these questions, we use an international sample of green and non-green (henceforth: 'conventional') bonds issued by US, Western European, and Chinese firms between 2013 and 2021. We first replicate Tang and Zhang's (2020) and Flammer's (2021) event study results. Consistent with these authors, we find evidence of significant positive green bond announcement returns over the period 2013 to 2018, with the positive effect stronger for first-time issues. Over the same sample period, we also find that green bond announcement returns are significantly more positive than the stock price reactions for our sample of conventional bond issues. However, when we extend the sample period from 2018 to 2021, green bonds' positive announcement effect evaporates. Overall, we provide evidence of a decreasing trend in stock price reactions to corporate green bond issuance announcements over our full sample period, consistent with the notion that environmental Corporate Social Responsibility (CSR) is a corporate activity with decreasing marginal returns (Flammer, 2013).

We next turn to testing the determinants of inter-firm differences in green bond announcement returns. We derive novel hypotheses on the determinants of green bond announcement results from the four main distinctive features of corporate green bonds compared with conventional bonds. In line with these hypotheses, we find that shareholders perceive green bonds as more beneficial for firms with lower proprietary costs, higher reputational gains from being seen as green, a stronger focus on innovation, and higher debt capacity. Conversely, none of these determinants are significant in explaining conventional

bond announcement returns. We also find more positive green bond announcement returns for financial firms and green bond issuers domiciled in China. We furthermore find that green bond announcement returns are negatively influenced by two major environmental shocks over our sample period, i.e. the US Paris Agreement withdrawal and the global outbreak of COVID-19. The negative time trend in the green bond announcement returns disappears after controlling for these shocks. We argue that these two events may have shifted investor opinions regarding the desirability of environmentally friendly projects financed by green bonds. These two shocks do not negatively affect conventional bond announcement returns.

In a robustness test, we adopt a Heckman two-stage procedure analysis to address a potential sample selection bias resulting from firms' non-random choice between green and non-green bonds (Dutordoir et al., 2022). Results from this additional analysis confirm the results from the baseline regression analysis. Our baseline results survive several other robustness tests.

Overall, our event study results obtained using recent green bond offering announcements provide a more nuanced, less optimistic view on the impact of green bond offerings on shareholder value. Moreover, our analysis highlights a set of announcement return determinants that are unique to green bonds and can be traced back to the distinctive features of these securities. As such, we hope our results are relevant to corporate green bond issuers, and investors, as well as to regulators of green bond markets.

The remainder of this paper is structured as follows. Section 2 positions our paper within the broader literature. Section 3 develops the dataset and empirical design. Section 4 discusses the univariate analysis of green bond announcement returns. Section 5 presents and analyzes

potential determinants of corporate green bond announcements. Section 6 summarizes the main results and outlines our paper's limitations and (practical) implications.

2. Literature review

Our research is related to the extensive theoretical literature on the shareholder value effect of different types of security offerings. A widely recognized explanation is information asymmetry: information about the firm's earnings prospects, investment opportunities, or assets in place is unevenly distributed between the firm's managers and investors (Myers and Majluf, 1984). A typical finding is that equity offering announcements provide a signal of firm overvaluation, and both initial and seasoned offerings therefore yield negative stock returns (Downes and Heinkel, 1982; Myers and Majluf, 1984; Asquith and Mullins, 1986; Masulis and Korwar, 1986; Mikkelson and Partch, 1986; Eckbo and Masulis, 1995; Jung et al., 1996). For the announcement of convertible bonds with hybrid features of both debt and equity, event studies on stock price reactions document negative effects, that are however smaller in size than those for equity offerings (Dann and Mikkelson, 1984; Eckbo, 1986; Mikkelson and Partch, 1986; de Roon and Veld, 1998; Abhyankar and Dunning,1999; Burlacu, 2000; Ammann et al., 2006; Dutordoir and Van de Gucht, 2007). By contrast, results on announcement returns of straight bond offerings are inconclusive. On the one hand, higher debt ratios can signal positive managerial expectations concerning future cash flows or lower agency costs, thus leading to a positive revaluation of the firm's value (Jensen and Meckling, 1976; Ross,1977; Barclay and Smith, 1999). On the other hand, larger-than-expected external financing reveals a lower-than-expected operating cash flow, leading to a negative stock price reaction (Miller

and Rock, 1985). Eckbo et al. (2007) show an insignificant impact of straight bond offering announcements on the issuer's stock price.

We contribute to this stream of prior literature by examining how the stock market reacts to green bond offerings, a relatively novel financing instrument. Unlike prior literature (Tang and Zhang, 2020; Flammer, 2021), we are the first to reveal a decreasing trend in green bonds' positive announcement effect, and to document the determinants driving green bond announcement returns. Moreover, the prior literature does not draw any conclusions about the determinants of cross-sectional differences in green bond announcement returns. In this study, we address this gap by developing and testing five novel hypotheses. Finally, our study takes a broader view of asset pricing implications and explicitly takes into account the influence of climate regulations and health uncertainty. Within this stream of literature, some prior empirical studies have examined the effect of uncertainty in economic policy (e.g., Brogaard and Detzel; 2015), politics and elections (e.g., Liu et al., 2017), and tax and fiscal conditions (e.g., Belo et al.; 2013) on shareholder value. Our study complements these papers by investigating the financial implication of environmental regulations and a health shock (i.e. COVID-19) on the stock market reception of green bond announcements.

Our study also fits into a rapidly growing literature on whether and how investments in CSR activities impact a firm's value in the short run. In line with the argument that environmental CSR generates new and competitive resources for firms (Serafeim and Yoon, 2021), the announcement of increases in CSR activities may positively affect shareholder value. Accordingly, several studies find that companies' eco-friendly behaviors result in positive stock price reactions, consistent with the "doing well by doing good" argument (Klassen and

McLaughlin, 1996; Flammer, 2013; Servaes and Tamayo, 2013; Krüeger, 2015). An alternative perspective holds that commitment to CSR behaviors results in wasteful investment at the expense of shareholder interest, leading to higher agency costs (Krüger, 2015; Dutordoir et al., 2018).

Green bond announcements include two pieces of information: the news of a bond issuance and the news of a company's commitment to the environment (Tang and Zhang, 2020). Given that prior studies present inconclusive and often opposing findings on the announcement effects of straight bond offerings on the one hand, and CSR activities on the other hand, the dual nature of green bonds, therefore, leads to an ambiguous prediction on the sign of the effect of green bond announcements on stock returns.

3. Dataset and empirical design

3.1 Sample construction

Our sample consists of green and conventional straight (non-convertible) bonds issued by public firms domiciled in the US, Western Europe, and China from January 2013 to June 2021. We use Bloomberg, one of the most inclusive databases, to retrieve all corporate green bonds that are labeled as "green". We retrieve conventional bond data from the Securities Data Company (SDC)'s New Issues database, a standard database for studies on (global) corporate bond issuance (e.g. Gomes and Phillips, 2012; Gozzi et al., 2015). We limit our dataset to publicly listed companies since we require the availability of relevant firm characteristics. We thus obtain a sample of 906 green bonds and 43,292 conventional bonds. We further exclude bonds with a maturity lower than one year, perpetual bonds, and bonds without any of the

required issuer characteristics available. After imposing these criteria, the final sample includes 821 green bonds and 33,634 conventional bonds with relevant issuer characteristics measured at the year-end before the bond's issue date matched them. Then, we extract the announcement dates of green bond offerings from Bloomberg. For the conventional bonds obtained from SDC, we follow Duca et al. (2012) in our empirical design and identify their filing date in SDC as the their announcement date. After eliminating green and conventional bonds available filing dates, we have 706 announcement events for green bonds made by 285 issuers, and 2,927 announcement events for conventional bonds made by 718 issuers in our final sample. In the univariate analysis, we select one single bond issue with the largest issue amount when several tranches of bonds are issued by the same issuer on the same day, which gives us 483 green bond issuance events and 2,073 conventional bond issuance events. We collect the stock market data and country-specific market index for the country of domicile of the issuer from Datastream.

3.2 Event study methodology

We apply traditional event study methodology to estimate abnormal stock returns of green bond announcements. The basic premise for this method is semi-strong market efficiency (Fama, 1970): the market immediately absorbs public information and accurately reflects it in stock prices. The announcement date, instead of the actual issuance date, of green bond issuance (day 0) is the relevant date since it captures the day when information is conveyed to the market. We use market model regressions with estimation periods of 220 trading days ending 20 days before the green bond announcement date to calculate normal stock returns. Because we have cross-country data, we use the country-specific leading stock market index

for the issuer's country of domicile. To alleviate the concern that there is some information leakage of the bond issuance, or a slightly delayed market reaction e.g. due to announcements taking place post-stock market closure, we use event study windows [−1,1], [0,1], [−5,10], and [−10,10]. According to the market model:

$$R_{i,t} = \alpha_i + \beta_i R_{m,t} + \varepsilon_{i,t} \quad (1)$$

where $R_{i,t}$ is the return on the stock of (green) bond announcement event i on day t. $R_{m,t}$ is the daily market return[2], and $\varepsilon_{i,t}$ is the residual. The estimated return on the stock of event i on day t:

$$\widehat{R}_{i,t} = \hat{\alpha}_i + \hat{\beta}_i * R_{m,t} \quad (2)$$

The coefficients α_i and β_i of the market model are estimated by ordinary least squares (OLS) based on 200 trading days prior to the event window ([–220, –20]) using daily returns. Abnormal daily return (AR) of event *i* on day *t* is:

$$AR_{i,t} = R_{i,t} - E(R_{i,t}) \quad (3)$$

Then we sum daily abnormal stock returns within the specific time window and report corresponding *CAR*s.

4. Univariate analysis of green bond announcement returns

4.1 Replicating prior research on green bond announcement returns

In the section, we replicate prior research on green bond announcement returns and obtain very similar results in terms of the significance and magnitude of green bond announcement returns. Table 1, Panel A reports the mean *CAR*s for different time windows around the

[2] We extract stock prices and country-specific market index for the country of domicile of the issuer from Datastream (e.g., S&P 500 Index for US, SSE Composite Index for China, FTSE 100 for UK, etc).

corporate green and conventional bond announcements in the window from 2013 to 2018. We find positive statistically significant *CARs* of 1.132% (1.368%) in the event window [−5, 10] ([−10,10]), which are significantly different from zero at the 1% (5%) level, even higher than the 0.489% significant (at the 5%) positive stock price reaction in Flammer's (2021) study over window [−5, 10]. For completeness, we further proceed with a univariate comparison of green and conventional bonds announcement returns in Table 1, Panel B, and do find significant differences in stock price reactions in the event window [−5, 10] and [−10,10]. Table 1, Panel C further reports the results of *t*–test and Wilcoxon rank-sum test for differences in the means and median *CAR*s across the two samples. It reveals that stock price reactions to a firm's first green bond announcements are more prominent and positive in the event window [−10, 10], which is again consistent with Flammer (2021) and Tang and Zhang (2020) results, who find a 0.798% and 1.39% positive stock price reaction to first-time corporate green bond announcements at the 5% level over window [-5,10] and [−10, 10], respectively. This could be due to the fact that first-time issues are less anticipated by the market, and therefore have a more positive signaling power regarding the issuer's commitment to CSR activity. After the market has learned about the firms signaling commitments at the first-time issue, the stock return of subsequent green bond issues is not that significant (Flammer, 2021). Another possible explanation is that the profits of green projects might be larger for first-time issues, with future projects becoming less profitable (Flammer, 2013; Blanco et al, 2020). In conclusion, our results for the sample periods used by Tang and Zhang (2020) and Flammer (2021) are largely consistent with these authors' results, with differences in the actual estimates probably resulting from unavoidable discrepancies in our sample collection procedures.

<< Please insert Table 1 here >>

4.2 Green bond announcement returns during the full sample period

Since the corporate green bond market is maturing and has become increasingly active with a flux of new issues in recent years, we extend the green bond sample period to 2021 and re-visit the sign of stock price reactions to green bond announcements. Table 2 represents the stock market reaction to corporate bond announcements from 2013 to 2021. Panel A and Panel B in Table 2 report the average *CAR*s for different time windows around the corporate green and conventional bond announcements. We find that the positive green bond announcement returns evaporate during the full sample period. In Panel C, we further report the results of *t*–test and Wilcoxon rank-sum test for differences in the mean and median *CAR*s of green and conventional bonds, and find no significant difference across the two samples. Panel D reports insignificant average *CAR*s even for first-time issues of corporate green bonds over the full sample period.

<< Please insert Table 2 here >>

4.3 Trend of green bond announcement returns

Given that we find less positive *CAR*s for later years in our sample period, we now conduct a formal analysis on whether there is any decreasing trend in green bond announcement returns over the research period. Table 3, columns (1) and (2) report average stock price reactions to green and conventional bond announcements by year. Column (1) provides quantitative evidence of the green bond announcements and indicates a roughly steady decreasing evolution year by year. Corroborating this insight, a regression of the *CAR*s of corporate green bond

announcements on a yearly time trend variable and an intercept indicates a significant negative annual time trend of −0.207% in the average *CAR*s of corporate green bond announcements. In particular, the average *CAR*s of green bond announcements are significantly higher than that of conventional bond announcements in the year 2013, while becoming significantly lower than that of conventional bond announcements by the year 2020.

<< Please insert Table 3 here >>

5. Potential explanations for the (green) bond announcement returns

In this section, we discuss the potential determinants of green bond announcement returns. Through this analysis, we hope to explain the negative time trend in green bond announcement returns documented in the previous section, as well as providing more insight into the inter-firm differences in these returns.

5.1 Hypotheses on the determinants of green bond announcement returns

According to the semi-strong form market efficiency theory, stock prices instantaneously and fully incorporate any public information that changes shareholders expectations of firms' future cash flows (Fama, 1970). Thus, stock price reactions to corporate announcements will be positive (negative) to the extent investors' perceive the news will positively (negatively) affect firms' discounted further cash flows. Green bond issuer characteristics may affect the way green bond announcements are perceived by shareholders and therefore the stock price reaction to green bond announcements, as they may proxy for the relative benefits and disadvantages of a green bond offerings.

This consideration leads us to develop five hypotheses, which are consistent with the

hypotheses Dutordoir et al. (2022) used to explain firms' choice between green and conventional bonds. Our first hypothesis is based on the incremental disclosure requirements for green bonds. Unlike conventional bond issuers, who can simply state that they will use the bonds for "general corporate purposes", green bond issuers are required to disclose the process used to determine the eligibility of green projects, the actual use of proceeds, and the process to manage the environmental and social risks of these projects (ICMA, 2021). Next to the costs of preparing and disseminating this required information, the disclosed information could be harmful to the firm's competitiveness (Verrecchia, 1983; Cohen, 2011; Monk, 2017). Consistent with this perspective, investors may perceive green bond issuance as less favorable for firms with high costs of disclosure. We refer to this as the disclosure cost hypothesis:

H1: *Role of disclosure costs*. Green bond announcement returns will be negatively influenced by higher disclosure costs.

The second hypothesis pertains to potential reputational gains associated with green bond issuance. Firms signal their key characteristics to stakeholders through various actions, including CSR initiatives, thereby building up a reputation (Turban and Greening, 1997; McWillliams and Siegel, 2001; Eichholtz et al., 2010). Ultimately, these reputational gains can lead to an improved relations with consumers, employees, and investors (Fombrun and Shanley, 1990; Stroebel and Wurgler, 2021; Sangiorgi and Schopohl, 2021), a lower cost of financing (Ge and Liu, 2015) and better financial performance (Orlitzky et al., 2003), collectively resulting in an increase in the net present value of expected future cash flows. Hence, shareholders may perceive green bonds as more favorable for firms with higher reputational gains from showing a dedication to environmental performance. We thus obtain the following

hypothesis:

H2: *Role of reputational gains*. Green bond announcement returns will be positively influenced by reputational gains from showing a dedication to environmental performance.

The third hypothesis applies to green bonds' association with corporate innovation. The few empirical studies on firms' financing of innovative activity tend to focus on cash reserves, stock issues, and venture capital (Brown et al., 2009; Nanda and Rhodes-Kropf, 2017), rather than on corporate bonds. This is consistent with the fact that innovative activity is inherently risky (Sorescu and Spanjol, 2008; Ren et al., 2022), making bond financing less appropriate a priori. However, anecdotal evidence from corporate announcements of green bond issues suggests that, in contrast with conventional bonds, green bonds are frequently used to finance corporate innovations (Dutordoir et al., 2022). Against this backdrop, the hypothesis builds on the fact that green projects funded by green bonds, e.g., energy and waste management, source reductions resulting in higher output for the same inputs (process intensification), and the development of green technology and eco-products, could lead to a sustained corporate advantage and hence improve the outlook on cash flows and stock returns (Bansal and Roth, 2000). It seems logical that green bonds by firms with a more innovative corporate culture will be more prone to be rewarded by the stock market, since the firm has the necessary innovative abilities to bring the green projects to a good ending. We thus obtain the third hypothesis:

H3: *Role of innovation*. Green bond announcement returns will be positively influenced by an innovative focus.

Our fourth hypothesis is based on the fact that green bonds are in essence a conventional bond with a green label (Tang and Zhang, 2020). Therefore, shareholders may perceive green

bonds as more favorable for firms with a higher remaining debt capacity, leading to a lower incremental risk of attracting incremental straight debt, and a lower cost of new debt. Accordingly, we propose our fourth hypothesis:

H4: *Role of debt capacity*. Green bond announcement returns will be positively influenced by a higher debt capacity.

The last hypothesis is based on the effect of economy-wide environmental shocks, which may affect investors' assessment of the cash flow implications of green initiatives like green bond issuance. Over our sample period, three important environmental shocks took place. The first is the US Paris Agreement Participation.[3] We expect to observe more positive abnormal announcement returns for green bond issuance, given that 195 governments were incentivized to push further to fight against climate change, with green bonds being an important tool to achieve this goal. The second event is the US withdrawal from Paris Agreement,[4] which would loosen, dismantle, or even upend some states' environmental and climate regulations that limit CO2 emissions and reduce firms' incentives to engage in green investments. Following this shock, investors may react less favorably to green initiatives (Lucia et al., 2022). The third shock is the global outbreak of the COVID-19 pandemic.[5] The direction of the expected impact

[3] In undertaking the international agreement adopted on 12 December, 2015 from the 21st Conference of the Parties, 195 governments agreed to control the environment degradation and keep the global average temperature well below rising to 2°C above what it had been before the industrial revolution – and preferably to keep it below 1.5°C (Bolton and Kacperczyk, 2021).

[4] President Trump announced in June 2017 that the US would pull out of the Paris Agreement, but the United Nations were officially notified of the US intention to withdraw from the Agreement on August 4, 2017. Please see: https://news.un.org/en/story/2017/08/562872-un-officially-notified-us-intention-withdraw-paris-climate-pact.

[5] The World Health Organization (WHO) declared COVID-19, an infectious disease which first broke out in China, to be a Public Health Emergency of International Concern (PHEIC) posing a high risk to countries with vulnerable health systems on January 30, 2020, and further named the disease COVID-19 on February 11 and declared it a a pandemic on March 11, 2020 (WHO, 2020; Ding et al., 2021). However, there is no consensus on the exact start date of COVID-19. Some studies label the post-COVID period starting from February 3, 2020 (Alexandre and Petit-Romec; 2020), very close to the start date of the "fever" period (i.e., February 24 to March 20) in Ramelli

of COVID-19 on stock price reactions to green issues is unclear a priori. On the one hand, some anecdotal evidence suggests that COVID-19 may distract investors' attention away from environmental issues (Morgan, J.P., 2020). In addition, according to a survey conducted by Stroebel and Wurgler (2021), respondents are three times as likely to believe that the payoffs of green projects occur primarily in good economic times than in bad economic times when evaluating the uncertain expected benefits of an investment in climate change abatement initiatives. According to these rationales, we expect shareholders to react less favorably to green bond announcements following the pandemic shock. An alternative view implies that investors' awareness of environmental issues is even more pronounced during the pandemic (Albuquerque et al., 2020). Consisten with this viewpoint, a Financial Times article mentions that "*when the dust settles from the coronavirus pandemic, the practice of investing in companies that conform to various ESG standards, whether it be to do with carbon emissions or workplace diversity, will be still a growing force in capital markets*" (Powell, 2020). The COVID-19 crisis may reinforce investors' focus on sustainability and reward firms engaging in sustainability with favorable associated stock returns (Mooney, 2020; Pastor and Vorsatz, 2020; Garel and Petit-Romec, 2021). We thus develop the fifth hypothesis:

H5: *Role of investor attitudes toward green activity.* Green bond announcement returns will be positively influenced by US Paris Agreement participation, while negatively influenced by the US withdrawal from the Paris Agreement. We have an ambiguous prediction the impact of the COVID-19 pandemic.

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and Wagner (2020) and in Albuquerque et. al (2022). In this study, we set the post-COVID starting from February 1, 2020.

5.2 Proxy variables capturing issuer-specific benefits and costs of green bonds

Previous studies on corporate finance have outlined the difficulty of finding a unique proxy to test a given hypothesis (Dutordoir et al., 2014). The same issue holds in our study: some of the proxy variables overlap across hypotheses since they can capture different constructs. Rather than using a single proxy for a given hypothesis, we, therefore, use a basket of suitable proxies capturing issuer-specific benefits and costs of green bonds suggested by the literature for each hypothesis. The Appendix provides detailed definitions of all of the variables and their sources, which constitute Bloomberg, SDC, and Worldscope.

To test H1, we construct four commonly used proxies for firms' proprietary costs. The first variable is the Herfindahl-Hirschman Index (HHI) of industry concentration. Information disclosure is more likely to affect competitors' actions, thereby eroding the firm's competitive advantage, in more concentrated industries (Bamber and Cheon, 1998). We thus expect a higher HHI to be associated with higher disclosure costs. The second variable is the firms' proportion of tangible over total assets (Tangibility). Sizable tangible assets are generally interpreted as a major barrier to entry. If the barriers to entry into a product market are relatively high, the associated costs of disclosure should be lower (Cohen, 2011). The third variable captures the issuer's Research and Development expenses (R&D). Firms with higher R&D are expected to face higher proprietary costs associated with sharing information about their activities (Ellis et al., 2012; Grewal et al., 2019). The last proxy variable is a high-tech indicator (High-Tech). Firms in high-tech industries are exposed to a more volatile environment with stronger potential entry threats and may therefore face higher costs of disclosing proprietary information (Leone et al. 2007; Pan et al., 2019).

To test H2, we adopt the following measures. Our first proxy is the HHI index, which we apply as an inverse measure for industry competition. We expect that firms in more competitive industries have stronger incentives to enhance their reputation through green bond issuance, since this may lead to a sustained competitive advantage (Branco and Rodrigues, 2006). Reputation is an intangible asset and may be more valuable for firms that more strongly depend on intangible assets. As inverse proxies for the role of intangible assets for the firm, we use the firm's book-to-market ratio (BTM) (Billet et al., 2014) and Tangibility. Another proxy, EScore, signals the firm's environmental performance, and firm's commitment and effectiveness toward adopting responsible initiatives on environmental issues before the bond offering. Firms' environmental performance may affect reputational gains from green bond issuance in different ways. On the one hand, higher ex-ante environmental performance may amplify the positive reputational effects of green bond issuance, since the signal (green bond issuance) aligns well with the firm's overall business strategy geared towards environmental performance (Ginder et al., 2021). On the other hand, firms with poor environmental performance may have more to gain, incrementally, from green bond issuance, since the offering would adjust the stakeholder perceptions of the company more substantially than for firms already scoring high on environmental performance. Finally, we construct a measure for the firm's advertising intensity (Advertising). Fombrun and Shanley's (1990) reputation model considers advertising as one of the reputation-building tools available to firms. Firms may use advertising and green bond issuance as complements or substitutes in attempting to enhance their reputation, making the predicted impact of Advertising ambiguous.

To test H3, we use R&D and High-Tech as proxies for firms' innovative focus. Firms with

more intense R&D investment and industries characterized by new and rapidly changing technology are typically more innovative (Chung et al., 2021; Ren et al., 2022). We note that we have no unique proxies to test H3 since these same proxies are also used to test H1. However, their predicted signs under H3 are opposite to those for H1.

To test H4, following previous research, we consider the following proxies for firms' debt capacity: tangibility (Tangibility), book-to-market ratio (BTM), profitability (ROA), firm size (Size) and leverage (Leverage) (Lemmon and Zender, 2010; Dutordoir and Hodrick; 2012). Firms' debt capacity is based on their underlying characteristics. Firms with more tangible assets, higher book-to-market ratios, higher profitability, lower leverage ratios, and higher total assets are more likely to have access to conventional bond markets (Faulkender and Petersen, 2006) and therefore have higher debt capacity. In addition, we construct a PriorConventional dummy variable indicating whether firms issued conventional bonds previously during the sample period to measure firms' access to the conventional bond market. Table 4 summarizes the proxy variables, the hypotheses they test, and their predicted signs under the different hypotheses.

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5.3 Baseline analysis

We examine differences in the bond and firm characteristics that issue green and conventional bonds in Table 5.[6] To reduce the effect of outliers, all continuous variables are winsorized at the top and bottom 5% of their distribution. In Table 5 Panel A, we find that green

[6] We have quite substantial drops in the number of observations due to missing bond filing data. However, we find that the general characteristics (e.g. Tangibility, R&D, ROA, Size) of the conventional bond issuers that we include are not materially different from those of conventional bonds that we exclude due to missing announcement dates.

bonds have larger issue proceeds (IssueAmount), and worse credit ratings (MoodyRating) than conventional bonds, with fewer rated green bonds (Rated). Table 5, Panel B reports mean issuer characteristics. As for the summary statistics at the issuer level, there are significant differences between green and conventional bond issuers. Specifically, green bond issuers have, on average, larger values than conventional bond issuers on firms' HHI, Tangibility, R&D expenses, and EScore, while smaller values on Advertising, ROA, and Leverage. In addition, there are fewer green bonds than conventional bond issuers in High-Tech industries and industrials, and in the US and China, but more green bond issuers in financials and utilities, and after the outbreak of the COVID-19 pandemic. The Appendix provides detailed definitions of the characteristics.

<< Please insert Table 5 here >>

To assess multicollinearity, we calculate pairwise Pearson correlation coefficients between the continuous explanatory variables. Table 6 presents the results. The highest correlation is between R&D and HHI (0.819). Other pairwise correlations are substantially smaller. Moreover, the unreported value of VIF for each variable is less than 10, leading us to conclude that multicollinearity is not a problem in our dataset.

<< Please insert Table 6 here >>

Table 7 reports stock price reactions to green bond announcements in narrow windows around the three external shock events considered in our study. We find no evidence that investors' positive reactions to green bond announcements are more pronounced following the Paris Agreement, and we thus exclude this shock from further cross-sectional tests. Supporting our prediction in section 5.1, we document that the average *CAR* is 0.333% before the withdrawal from the Paris Agreement, while it becomes −1.499% after this shock. Moreover,

we further investigate whether the post-COVID green bonds differ in terms of shareholder wealth effects from pre-COVID offerings. The results indicate that there indeed exists a pandemic-induced decline in green bond *CAR*s following COVID-19. The average *CAR* is −0.179% before COVID-19 while it becomes −0.829% after the pandemic. To visualize the stock market reaction, we show the average *CAR*s of corporate green bond announcements immediately before and after three events in Figure 1.

<< Please insert Table 7 here >>

<< Please insert Figure 1 here >>

Based on the hypothesis predictions, we next specify cross-sectional regressions relating the green bond announcement return to the observable issue- and firm-characteristics and exposures to exogenous environmental shocks, including indicator variables capturing the country and industry fixed effects. The dependent variable in the cross-sectional analysis is the firm-specific cumulative abnormal return (*CAR*). We run the following baseline cross-sectional regression analysis:

$$\begin{aligned} CAR_i = {} & \beta_0 + \beta_1 \mathrm{HHI}_i + \beta_2 \mathrm{Tangibility}_i + \beta_3 \mathrm{R\&D}_i + \beta_4 \mathrm{High\text{-}Tech}_i + \beta_5 \mathrm{ROA}_i \\ & + \beta_6 \mathrm{Size}_i + \beta_7 \mathrm{Leverage}_i + \beta_8 \mathrm{BTM}_i + \beta_9 \mathrm{PriorGreen}_i + \beta_{10} \mathrm{PriorConventional}_i \\ & + \beta_{11} \mathrm{E\ Score}_i + \beta_{12} \mathrm{Advertising}_i + \beta_{13} \mathrm{Issue\ Amount}_i + \beta_{14} \mathrm{Moodyrating}_i \\ & + \beta_{15} \mathrm{Maturity}_i + \beta_{16} \mathrm{Financials}_i + \beta_{17} \mathrm{Utilities}_i + \beta_{18} \mathrm{WE}_i + \beta_{19} \mathrm{China}_i \\ & + \beta_{20} \mathrm{WithdrawParis}_i + \beta_{21} \mathrm{COVID19}_i + \mu_i \end{aligned} \quad (1)$$

Where CAR_i is the Cumulative Abnormal Return (*CAR*) of firm i. β_0 is the intercept. β_i (i =1, 2, …, 15) are the coefficients of explanatory variables. μ is the error term.

Table 8 reports the estimates of the OLS regressions of abnormal stock returns around green bond announcements. Reported *t*−statistics of all regressions in the paper are based on

robust standard errors. In Column (1), we run a baseline regression in which we only include the time trend and an intercept. We find a significant decrease in green bond announcement returns of −0.3% per year, consistent with the earlier univariate results. In Column (2), we test whether this time trend persists when controlling for issue-specific variables. We find that this is the case. The coefficient of the Trend variable remains negative and significant, suggesting that the declining green bond announcement returns seems to be unrelated to shifts in characteristics of green offerings such as IssueAmount, MoodyRating, and Maturity. Table 7 suggests that the withdrawal from the Paris Agreement and the outbreak of COVID-19 are associated with shifts in investors' attitudes to green activities and lead to significant declines in green bond announcement returns. To examine this conjecture more formally, we re-estimate the regression model while including the time trend and dummy variables capturing each of the two events. Each event dummy variable has a value of zero before the relevant event date and one afterward. Accordingly, the coefficients on the dummy variables represent the changes in green bond announcement returns relative to the period preceding the event. Table 8, Column (3) reports the findings. The two events dummy variables have significant negative coefficients, in line with green bond announcement returns being less favorable after these two external environmental regulation shocks. Notably, the negative coefficient of COVID-19 is inconsistent with theories predicting that COVID-19 reinforces investors' focus on sustainability and rewards firms engaging in sustainability. Most importantly, the time trend coefficient is no longer statistically significant following the introduction of these two event dummies. Thus, our results are in line with environmental regulation as an explanation for the decline in green bond announcement returns.

In the remaining analyses, we further quantify the component of the green bond announcement returns that is also attributable to changes in issuer-specific characteristics. When we include both issue- and issuer- characteristics related to the aforementioned

explanations, it is worth noting that the coefficients of the Trend variable again are no longer significant. In Column (4), among these characteristics, cross-sectional analysis of green bond announcement returns indicate a positive relationship to firms' Tangibility, R&D, EScore, Advertising, and Size changes. Specifically, the stock prices have been greater among firms with higher Tangibility, in line with H1 and H4. In terms of economic significance, a one standard deviation increase in Tangibility increases announcement returns by 1.9%. Secondly, firms with higher EScore and Advertising enjoy better stock price performance in response to the green bond issuance. These results are consistent with the view that CSR commitment and firms' visibility increase strengthen issuers' reputation gains and lead to more pronounced announcement returns (H2). Moreover, we also find that firms with higher R&D have more favorable *CAR*s associated with green bond announcements, in line with H3. Specifically, the small albeit significant coefficient of R&D indicates that a one standard deviation increase in R&D increases announcement returns by 0.3%. Coefficients on other explanatory variables are not significant. Our results remain similar when we add event dummies successively in Columns (5) and (6).

The empirical evidence also provides industry- and country-level analyses of how industry and country characteristics influence investor concerns about the cash flow implications of green bond issuance. A priori it is unsure to what extent these factors would influence investor reactions. We find that the stock price reaction to green bond announcements is more positive in the financial industry. Financial institutions generally resort to the green debt market via green lending, instead of investing directly in environmental-friendly projects (Fatica et al., 2021). Furthermore, we find country-specific differences in terms of green bond announcement returns between China and other regions. The stock price reaction to green bond announcements is more favorable in China. This could be due to a variety of factors such as different legal systems, institutional contexts, and cultural differences which affect investors'

attitudes and practices toward green bonds, as well as towards green investment more generally (Sangiorgi and Schopohl, 2021). Specifically, China's local governments are considered to be more prone to promote the development of green bond markets, thereby reducing financing costs for green issuers through a combination of policy and regulatory supports and fiscal and financial measures (e.g., an interest subsidy of 30 percent toward green bonds issuance) (Jun et al., 2019; Lgno et al., 2021; Wu, 2022).

<< Please insert Table 8 here >>

Table 9 provides more evidence regarding the relation between environmental regulation and healthy shocks (i.e. US Paris Agreement Withdrawal and the outbreak of COVID-19) and the stock price reactions of green bond issuance, by zooming in on a limited set of green bond announcement events occur either shortly before or after an environmental regulation event. The setup restricts the analysis to green bond issuance announced in narrow windows 300 trading days before and after the environmental shocks. In total, the analysis includes 346 announcements. The key independent variable of interest, environmental regulation shock (EnvironmentalShock), is equal to one for green bond issuance announced in the window [0, +300] following one of the external shocks, and zero for green bond issuance announced 300 trading days before one of two shocks (in the window [−300, 0]). WithdrawParisNarrow is coded as one for all green bond offerings made in narrow window 300 trading days before and after the US Paris Agreement Withdrawal. COVID19*Narrow* is coded as one for all green bond offerings made in narrow window 300 trading days before and after the global outbreak of COVID-19. In Column (1) of Table 9, the environmental regulation shock dummy variable has a negative coefficient. This suggests that declines in green bond announcement returns are indeed associated with environmental regulations events, corroborating the evidence in Table

7. The coefficients of EnvironmentalShock are still significantly negative after controlling for shocks fixed effects in Column (2) and region and industry fixed effects in Column (3). Column (4) indicates that this result still holds while including significant issue- and issuer-specific variables used in the baseline regression.

<< Please insert Table 9 here >>

For completeness, we also replicate the baseline regression analyses to reveal the stock price reactions to conventional bond announcements. The setup is similar to the analysis reported in Table 8 which reports the estimates of the OLS regressions of abnormal stock returns around green bond announcements. We find no significant trend in conventional bond announcement returns over the research period. Furthermore, coefficients on other explanatory variables are not significant except for the High-Tech indicator, revealing a stronger positive conventional bond announcement return for issuers in the High-Tech industry. The results are robust when we simultaneously control for the external shocks.

<< Please insert Table 10 here >>

In a further test, we further uncover significant differences in the determinants of stock price reactions to green and conventional bond announcements by comparing the regression coefficients across green and conventional bond samples. Table 11 reports the baseline regression coefficients for the two groups and reports *Chi*-square tests for the difference between coefficients for green and conventional *CAR*s. Green bond announcement returns are positively influenced by firms' Tangibility, R&D, Environment score, and Advertising, while conventional bond announcement returns are not significantly affected by these determinants. These findings corroborate that our findings for the determinants of green bond announcement

returns derive from the unique features of green bonds, and are therefore not shared by conventional bonds.

<< Please insert Table 11 here >>

5.4 Robustness tests

In what follows, we briefly discuss a series of unreported robustness tests. First, we re-run the models with alternative corresponding market indexes and alternative methods (market-adjusted model). The *CAR* results remain similar. Second, we drop dual issuers (defined as firms who issue green and conventional bonds in the same month) from the analysis. We obtain largely similar findings, except that the coefficient of Withdrawal is no longer significant.

An important caveat to observed announcement effects is that they are conditional on firms self-selecting into a particular security type (Dutordoir and Hodrick, 2012). The OLS estimators in cross-sectional regressions are inconsistent if a corporate event is voluntary and investors are rational (Eckbo et. al, 1990). In the context of our research design, the green bond sample is truncated by the firms' earlier decision to issue green bonds instead of conventional bonds. If unobservable characteristics associated with the decision of green bonds issuance also influence the way the market reacts to green bond announcements, this could impose a self-selection bias on our main findings (Li and Prabhala 2007; Roberts and Whited 2012). To alleviate endogeneity issues and further test our previous results, we use a two-step Heckman procedure. The first step of this procedure involves estimating a probit model with a green bond dummy equal to one for green bond issues and zero for conventional bond issues as the dependent variable, and the same explanatory variables as those in the announcement return regression. The second step involves regressing the green bond announcement return on the

same explanatory variables as those in our baseline analysis, as well as an inverse Mills ratio obtained from the first step. In the unreported results, we find the coefficient of the inverse Mills ratio is insignificant, consistent with the notion that self-selection does not play a role in explaining the effect of possible determinants on green bond announcement returns in our study. In summary, our results continue to hold in a two-step Heckman procedure that controls for self-selection bias.

6. Conclusion

This study analyzes the shareholder value effects and determinants of immediate stock price reactions to green bond announcements, with an international sample of green and conventional bonds issued by US, Western European, and Chinese firms between 2013 and 2021. We document that the positive stock price reaction to green bond announcements documented by earlier studies disappears from 2018 onwards. Further analysis reveals a statistically significant negative time trend in stock price reactions to the announcements of green bond offerings. Overall, green bond announcements no longer generate more positive stock price reactions than conventional bond announcements.

We then report new evidence on the drivers of green bond announcement returns. Our findings, obtained through cross-sectional regressions, point to those issuers with lower disclosure costs, higher reputational gains, more innovation, and higher debt capacity experiencing better stock price reactions to corporate green bond announcements. Furthermore, we document that the decreasing trend in green bond announcement returns disappears after controlling for two external environmental shocks: the US Paris Agreement withdrawal and the global outbreak of COVID-19. We further uncover significant differences in the determinants of stock price reactions to green and conventional bond announcements. We document the

robustness of our main results by conducting a range of tests.

An unavoidable limitation of our empirical design is the lack of unique proxy variables to examine individual hypotheses. We encourage future academic research using more fine-grained measures, for example, patent data to capture firms' innovative focus. However, this would likely come at the expense of a reduced sample size, which could be a problem given the still limited size of the corporate green bond market.

Our findings are relevant for corporate managers, board members, and investment banks by providing more insight into the shareholder value effects of green bond issuance. Our results also help investors better understand the stock price dynamics around green bond issuance announcements, thus enabling them to evaluate the appropriateness of a given green bond announcement. Finally, our results are relevant for policy makers involved in green bond market development.

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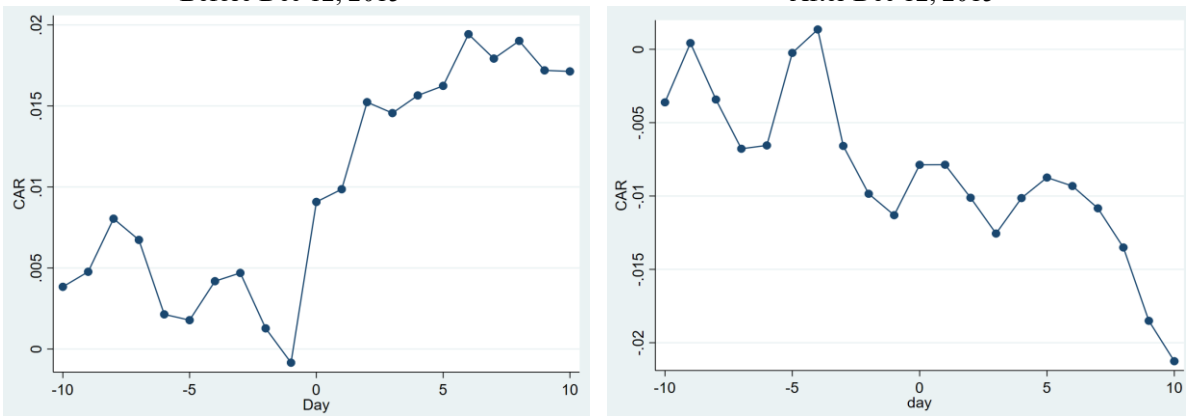
Figure 1. The average *CAR*s of corporate green bond issuance announcement immediately before and after three events.

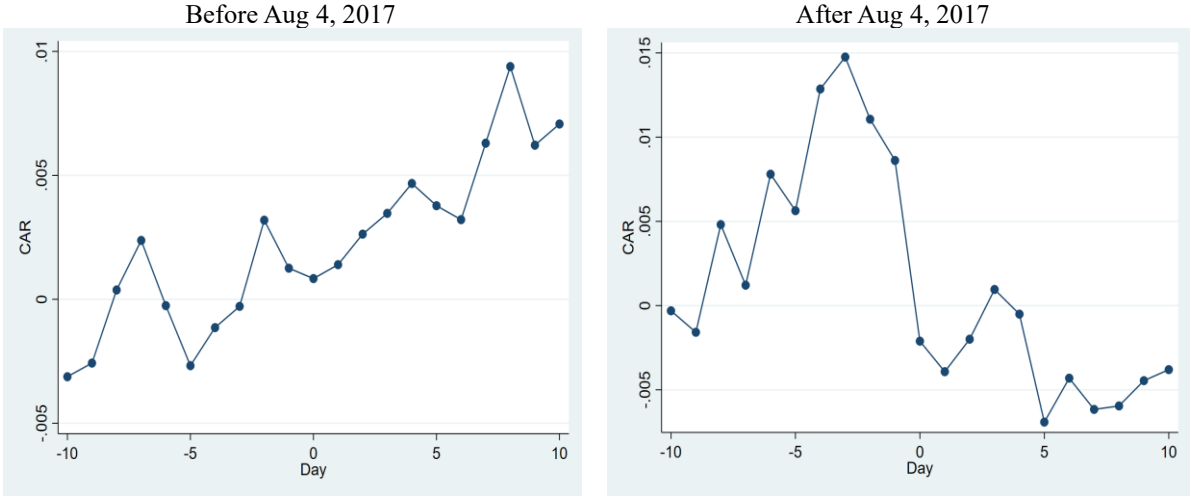
Event 1: US Paris Agreement Participation

Before Dec 12, 2015 | After Dec 12, 2015



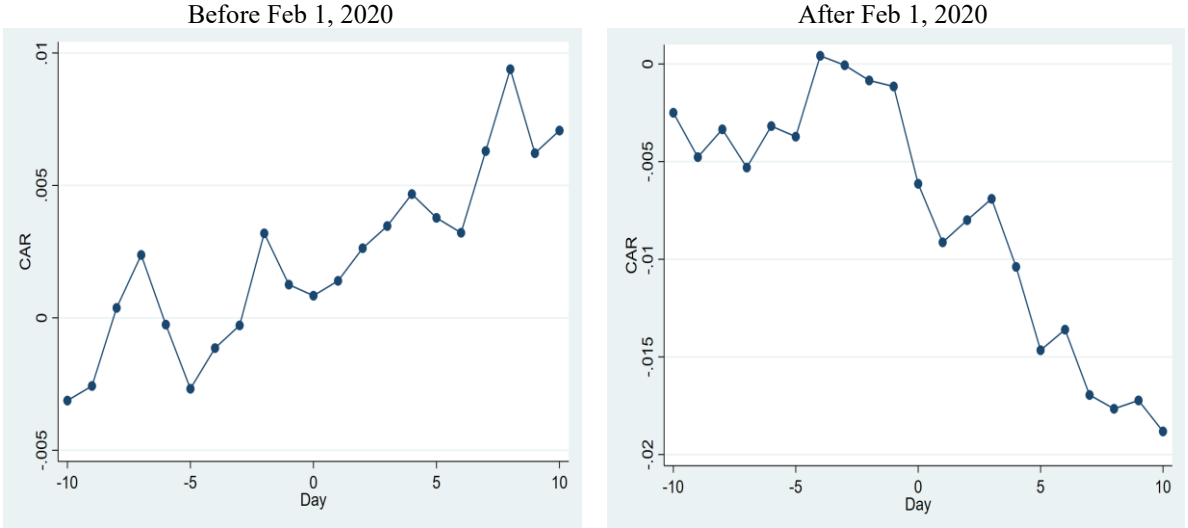
Event 2: US Paris Agreement Withdrawal

Before Aug 4, 2017 | After Aug 4, 2017



Event 3: The global outbreak of COVID19

Before Feb 1, 2020 | After Feb 1, 2020



Notes: Figure 1 reports graphs in which we analyze only the average CARs of corporate green bond announcement in 300 trading days windows before and after the two events (US Paris Agreement participation and withdrawal and the outbreak of COVID19 in the world) associated with investors attitude towards green bonds issuance. Abnormal stock returns are estimated with market model regressions. We use a 200-day estimation window starting from 220 trading days before the announcement to 20 trading days before the announcement.

Table 1. Stock market reaction to the corporate bond announcement from 2013 to 2018

Event window	Mean	Cross−sectional test	*p*−value	Median	Sign test	*p*−value	N
Panel A: Corporate green bond announcements							
[−1;1]	0.239%	1.088	0.28	0.206%**	2.513	0.01	178
[0;1]	0.240%	1.612	0.18	0.107%	1.345	0.18	
[−5,10]	1.132%***	2.633	0.01	1.426%***	6.555	0.00	
[−10;10]	1.368%**	2.349	0.02	1.069%***	4.653	0.00	

Panel B: Univariate tests of differences between green and conventional bonds						
Event window	Mean		*t*−test	Median		Wilcoxon−test
	Green	Conventional		Green	Conventional	
[−1,1]	0.239%	−0.127%	1.216	0.206%**	−0.033%	1.108
[0,1]	0.240%	−0.149%	1.523*	0.107%	−0.031%	1.445
[−5,10]	1.132%***	−0.093%	2.013	1.426%***	−0.039%	2.890***
[−10,10]	1.368%**	−0.065%	2.078**	1.069%***	0.030%	2.610***

Panel C: Green bond announcement returns for first-time issues							
Event window	Mean	Cross−sectional test	*p*−value	Median	Sign test	*p*−value	N
[−1,1]	−0.020%	−0.273	0.79	−0.048%	0.061	0.95	87
[0,1]	−0.132%	−0.339	0.74	−0.062%	0.061	0.95	
[−5,10]	1.106%**	2.394	0.02	1.407%*	1.778	0.08	
[−10,10]	1.462%**	2.354	0.02	1.086%**	2.421	0.02	

Notes: The table reports the mean *CARs* for different time windows around the corporate green and conventional bond announcements in the window from 2013 to 2018. We extract stock prices and country-specific market index for the country of domicile of the issuer from Datastream. The sample consists of 178 green bond announcements and 1,602 conventional bond announcements. We use a 200-day estimation window starting from 220 trading days to 20 trading days before the announcement. We test for the average *CARs* for different time windows that are not significantly different from zero. We adopt a cross-sectional test (Boehmer et al.,1991) and a generalized sign test (Cowan, 1992). *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 2. Stock market reaction to corporate bond announcements from 2013 to 2021

Event window	Mean	Cross−sectional test	*p*−value	Median	Sign test	*p*−value	*N*
Panel A: Corporate green bond announcements							
[−1,1]	−0.212%	−0.906	0.37	−0.042%	−0.819	0.41	483
[0,1]	−0.175%	−0.974	0.33	−0.090%***	−3.054	0.00	
[−5,10]	0.177%	1.031	0.30	0.245%***	2.626	0.01	
[−10,10]	0.256%	0.631	0.53	0.315%	0.648	0.52	
Panel B: Corporate conventional bond announcements							
[−1,1]	−0.024%	0.558	0.58	−0.111%	−0.552	0.58	2,072
[0,1]	−0.051%	0.438	0.66	−0.071%	0.196	0.84	
[−5,10]	−0.204%*	−1.938	0.05	−0.272%	−0.420	0.67	
[−10,10]	−0.012%	0.157	0.88	−0.263%	0.152	0.88	

Panel C: Univariate tests of differences between green and conventional bonds

Event window	Mean		*t*−test	Median		Wilcoxon−test
	Green	Conventional		Green	Conventional	
[−1,1]	−0.212%	−0.024%	−0.886	−0.042%	−0.111%	−0.566
[0,1]	−0.175%	−0.051%	−0.704	−0.090%	−0.071%	0.503
[−5,10]	0.177%	−0.204%*	0.879	0.245%	−0.272%	1.722
[−10,10]	0.256%	−0.012%	0.541	0.315%	−0.263%	1.375

Panel D: Green bond announcement returns for first-time issues

Event window	Mean	Cross−sectional test	*p*−value	Median	Sign test	*p*−value	N
[−1,1]	−0.448%	−1.539	0.125	−0.219%	−1.371	0.17	220
[0,1]	−0.361%	−1.145	0.254	−0.199%	−0.966	0.33	
[−5,10]	0.066%	0.795	0.427	0.309%	1.193	0.23	
[−10,10]	0.231%	0.156	0.876	0.228%	0.788	0.43	

Notes: Panel A and Panel B in this table report the average *CARs* for different time windows around the corporate green and conventional bond announcements. We extract stock prices and country-specific market index for the country of domicile of the issuer from Datastream. The sample consists of 483 green bond issuance events and 2,072 conventional bond issuance announcements. We use a 200-day estimation window starting from 220 trading days to 20 trading days before the announcement. We test for the average *CARs* for different time windows that are not significantly different from zero. We adopt a cross-sectional test (Boehmer et al.,1991) and a generalized sign test (Cowan, 1992). In Panel C, we report the results of *t*–test and Wilcoxon rank-sum test for differences in the means and medians *CAR*s across the two samples. Panel D reports the mean *CARs* of first-time issues of corporate green bond over the full sample period. We run a robustness check for event windows [0,1], [–5,10], and [−10, 10] in addition to the baseline event window [–1, 1]. *, **, and *** denote significance at the 10%, 5%, and 1% levels, respectively.

Table 3. Average stock price reaction to corporate bond announcements over time

Year	Green bonds (1)		Conventional bonds (2)		*t*−test	*p*−value
	CAR	N	*CAR*	N		
2013	2.393%	2	−0.211%	222	5.117*	0.06
2014	0.255%	11	−0.165%	204	0.569	0.58
2015	0.771%	38	0.033%	184	1.44	0.15
2016	0.584%	24	−0.335%	247	1.03	0.31
2017	−0.384%	43	−0.314%	304	−0.203	0.84
2018	0.135%	60	0.117%	207	0.049	0.96
2019	−0.218%	92	0.154%	225	−1.18	0.24
2020	−0.572%	115	0.362%	347	−1.81*	0.07
Jun. 2021	−0.603%	98	0.148%	132	−1.35	0.18
Trend	−0.207***		0.072*		–	–
p−value	0.00		0.07		–	–

Notes: This table reports the average stock price reaction to the green and conventional bond announcements over time. The sample consists of 483 green bond issues and 2,072 conventional bond issues from January 2013 to June 2021. We regress *CARs* on a yearly time trend variable. We report the coefficients and *p*−values of the time trend in the last two rows of this table. *, **, and *** denotes significance at the 10%, 5%, and 1% levels, respectively.

Table 4. Predicted sign of proxy variables for associated hypotheses

Proxy variables	Predicted signs under associated hypotheses (1)				Actual sign in the regression (2)
	H_1: Disclosure	H_2: Reputation	H_3: Innovation	H_4: Debt Capacity	
HHI	(−)	(−)			not significant
Tangibility	(+)	(−)		(+)	(+)
R&D	(−)		(+)		(+)
High-Tech	(−)		(+)		not significant
BTM		(−)		(+)	not significant
EScore		(+/−)			(+)
Advertising		(+/−)			(+)
ROA				(+)	not significant
Size				(+)	(+)
Leverage				(−)	not significant
PriorConventional				(+)	not significant

Notes: This table presents the predicted and actual impact of proxy variables capturing issuer-specific characteristics in terms of stock price reactions for corporate green bond announcements under each hypothesis. (+)/(−) indicates a positive/negative impact of proxy variables to the stock price reaction of issuing green bonds, with (+/−) indicating an ambiguous prediction. Column (2) provides the actual impact of the variables to stock price reactions in our baseline regression model.

Table 5. Comparing issue and issuer characteristics of green and conventional bonds

Variables	Green bonds (1)		Conventional bonds (2)		Difference between (1) and (2)	*t*−statistic/ χ^2−statistic
	N	Mean	N	Mean		
Panel A: issue characteristics						
IssueAmount ($M)	210	492.544	507	401.82	90.724	2.629***
MoodyRating	210	5.929	507	6.675	−0.746	−1.593
Rated (0/1)	210	40.95%	507	67.65%	−26.70%	44.049***
Maturity (years)	210	9.438	507	6.86	2.578	4.701***
Panel B: issuer characteristics						
HHI	210	0.087	507	0.064	0.022	3.159***
Tangibility	210	0.743	507	0.540	0.203	7.208***
R&D	210	3.710	507	0.724	2.987	7.081***
HighTech (0/1)	210	2.86%	507	8.87%	−6.019	8.141***
BTM	210	0.576	507	0.577	−0.002	−1.202
EScore	210	60.350	507	28.957	31.393	16.568***
Advertising	210	0.074	507	0.096	−0.022	−3.550***
ROA	210	4.228	507	5.009	−0.780	−2.816***
Size	210	7.337	507	7.300	0.037	0.658
Leverage	210	0.668	507	0.704	−0.036	−2.732***
FirstGreenBond (0/1)	210	0.32%	507	0.99%	−0.67%	413.51***
PriorConventional (0/1)	210	91.91%	507	81.68%	10.23%	12.007***
COVID19 (0/1)	210	38.09%	507	29.59%	8.51%	4.935**
Industrials (0/1)	210	47.62%	507	76.73%	−29.11%	58.008***
Financials (0/1)	210	29.05%	507	13.22%	15.83%	25.382***
Utilities (0/1)	210	23.33%	507	10.06%	13.27%	21.801***
US (0/1)	210	36.19%	507	69.23%	−33.04%	67.299***
Western Europe (0/1)	210	62.38%	507	3.95%	58.43%	305.012***
China (0/1)	210	1.43%	507	26.82%	−25.39%	61.281***

Notes: This table provides the issue and issuer characteristics of green bonds and conventional bonds issued between January 2013 and June 2021. The sample of green bonds is obtained from Bloomberg. The sample of conventional bonds is obtained from SDC. We verify the significance of differences in the mean values of continuous variables using pairwise *t*−tests. We verify the significance of differences in the values of dummy variables using χ^2−tests. The Appendix defines all variables. *, **, and *** denotes significance at the 10%, 5%, and 1% levels, respectively.

Table 6. Pearson correlation matrix

	HHI	Tangibility	R&D	High−Tech	BTM	EScore	Advertising	ROA	Size
Tangibility	−0.337***								
R&D	0.819***	−0.485***							
High−Tech	−0.005	0.125*	−0.105						
BTM	−0.693***	0.301***	−0.695***	−0.022					
EScore	−0.481***	0.266***	−0.578***	0.072	0.396***				
Advertising	0.678***	−0.450***	0.809***	0.048	−0.713***	−0.365***			
ROA	−0.297***	0.295***	−0.379***	0.133*	0.248***	0.198***	−0.263***		
Size	−0.519***	0.035	−0.510***	0.238***	0.517***	0.325***	−0.540***	0.187***	
Leverage	0.425***	−0.486***	0.581***	−0.019	−0.478***	−0.469***	0.462***	−0.321***	−0.042

Notes: This table reports the pairwise Pearson correlation coefficients between the continuous (non-dummy) issuer characteristics of green bonds issued between January 2013 and June 2021. The sample of green bonds is obtained from Bloomberg. The Appendix defines all variables. *, **, and *** indicate significance at 10%, 5%, and 1%.

Table 7. Stock price reaction to green bond announcements in narrow windows around three external shock events

Event	Mean *CAR*[−1,1]				*t*−statistic
	Before	N	After	N	
Paris Agreement Participation	0.859%**	63	0.219%	19	0.7593
Paris Agreement Withdrawal	0.333%	37	−1.499 %	52	−2.313**
Covid−19 Breakout	−0.179%	90	−0.829%	110	−1.341*

Notes: This table reports the average *CARs* in the event window over −1 to 1 relative to the green bond issuance announcement dates in 300 trading days before or after the environmental regulation and COVID−19 shocks. To calculate *CARs*, we use a 200-day estimation window starting from 220 trading days before the announcement to 20 trading days before the announcement and obtain *CARs* through market model regressions.

Table 8. Regression of stock price reactions to green bond announcements

	(1)	(2)	(3)	(4)	(5)	(6)
Trend	−0.003**	−0.003**	0.003	−0.000	0.001	0.004
	(−2.90)	(-2.30)	(1.02)	(−0.34)	(0.62)	(1.21)
HHI				0.022	0.027	0.028
				(0.29)	(0.34)	(0.36)
Tangibility				0.019*	0.020*	0.019*
				(1.90)	(1.97)	(1.96)
R&D				0.003**	0.003**	0.003**
				(2.21)	(2.19)	(2.11)
High-Tech				−0.016	−0.016	−0.015
				(−1.18)	(−1.24)	(−1.21)
BTM				−0.003	−0.003	−0.004
				(−0.33)	(−0.40)	(−0.44)
EScore				0.021*	0.021*	0.021*
				(1.70)	(1.72)	(1.67)
Advertising				0.154**	0.147**	0.155**
				(2.95)	(2.99)	(3.15)
ROA				0.000	0.000	0.000
				(0.21)	(0.08)	(0.11)
Size				0.013**	0.014**	0.014**
				(1.99)	(2.06)	(2.11)
Leverage				0.038	0.035	0.033
				(1.25)	(1.17)	(1.10)
FirstGreenBond		−0.007		0.006	0.007	0.008
		(−1.18)		(−1.12)	(−1.19)	(−1.35)
PriorConventional				0.017	0.017	0.017
				(1.40)	(1.45)	(1.43)
IssueAmount		0.004		0.004	0.003	0.003
		(1.19)		(0.60)	(0.38)	(0.46)
MoodyRating		−0.001		−0.000	−0.000	−0.000
		(−1.19)		(−0.65)	(−0.62)	(−0.72)
Maturity		−0.000		−0.000	−0.000	−0.000
		(−0.46)		(−0.35)	(−0.61)	(−0.68)
Financials				0.025**	0.024**	0.024**
				(2.13)	(2.06)	(2.09)
Utilities				−0.000	−0.000	0.001
				(−0.01)	(−0.05)	(0.06)
WithdrawParis			−0.020*			−0.013
			(−1.65)			(−1.01)
COVID19			−0.015*		−0.009	−0.012*
			(−1.89)		(−1.43)	(−1.70)
WE				0.022	0.022	0.022
				(1.52)	(1.50)	(1.49)
China				0.066**	0.064**	0.062**
				(2.14)	(2.08)	(2.02)
Intercept	0.017**	0.016**	−0.000	−0.284**	−0.290**	−0.295**
	(3.30)	(2.43)	(−0.04)	(−2.39)	(−2.42)	(−2.48)
N	210	210	210	210	210	210
R^2	0.039	0.055	0.055	0.241	0.247	0.250

Notes: This table reports the estimates of the OLS regressions of abnormal stock returns around green bond announcements. The sample consists of 210 green bond issuance announcements. The dependent variable is the average *CAR* in the event window over −1 to 1 relative to the green bond issuance announcement dates (with the announcement dates retrieved from Bloomberg). The Appendix provides the variable definitions. t−statistics, based on robust standard errors, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. N denotes the number of observations.

Table 9. Regression of green bond announcements return in narrow windows around shocks

	(1)	(2)	(3)	(4)
EnvironmentalShock	−0.008**	−0.007*	−0.007**	−0.011**
	(−2.37)	(−1.94)	(−1.99)	(−2.17)
Tangibility				0.012
				(0.99)
R&D				−0.000
				(−0.10)
EScore				0.009
				(0.80)
Advertising				0.143
				(1.54)
Size				0.015
				(1.45)
Financials			0.002	0.013
			(0.29)	(0.80)
Utilities			−0.001	−0.002
			(−0.19)	(−0.17)
WithdrawParisNarrow		−0.001	−0.000	0.008
		(−0.14)	(−0.08)	(1.05)
COVID19Narrow		−0.004	−0.004	0.005
		(−1.13)	(−1.07)	(0.76)
WE			0.006	
			(0.81)	
China			0.002	
			(0.29)	
Intercept	0.001	0.003	−0.003	−0.175
	(0.43)	(0.99)	(−0.28)	(−1.33)
N	346	346	346	143
R^2	0.018	0.021	0.028	0.109

Notes: This table provides more evidence regarding the relation between two environmental shocks (US Paris Agreement Withdrawal and the outbreak of COVID19) and the stock price reactions of green bond issuance by zooming in on a limited set of green bond issuance events made either shortly before or after an environmental regulation shock. *t*−statistics, based on robust standard errors, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. N denotes the number of observations.

Table 10. Regression of stock price reactions to conventional bond announcements

	(1)	(2)	(3)	(4)	(5)
Trend	0.001	0.000	0.001	0.002	0.001
	(0.58)	(0.26)	(1.19)	(1.49)	(0.55)
HHI			0.015	0.016	0.015
			(0.34)	(0.37)	(0.35)
Tangibility			−0.008	−0.008	−0.008
			(−1.57)	(−1.57)	(−1.58)
R&D			−0.002	−0.002	−0.002
			(−1.11)	(−1.12)	(−1.10)
High-Tech			0.012*	0.012*	0.012*
			(1.83)	(1.84)	(1.87)
BTM			0.005	0.005	0.005
			(0.70)	(0.73)	(0.72)
EScore			−0.000	−0.000	−0.000
			(−0.13)	(−0.10)	(−0.11)
Advertising			−0.036	−0.035	−0.036
			(−1.07)	(−1.02)	(−1.03)
ROA			0.001	0.001	0.001
			(0.86)	(0.85)	(0.81)
Size			0.005	0.005	0.005
			(0.78)	(0.77)	(0.78)
Leverage			−0.016	−0.016	−0.016
			(−0.92)	(−0.90)	(−0.90)
FirstGreenBond			0.037	0.036	0.036
			(−1.23)	(−1.22)	(−1.22)
PriorConventional			0.002	0.002	0.002
			(0.40)	(0.37)	(0.37)
IssueAmount			0.003	0.003	0.003
			(0.42)	(0.46)	(0.43)
MoodyRating			0.000	0.000	0.000
			(0.15)	(0.17)	(0.18)
Maturity			−0.000	−0.000	−0.000
			(−0.70)	(−0.73)	(−0.74)
Financials			−0.005	−0.005	−0.005
			(−0.96)	(−0.93)	(−0.95)
Utilities			0.006	0.006	0.007
			(0.93)	(0.93)	(0.95)
WithdrawParis		0.001			0.004
		(0.16)			(0.67)
COVID19		0.000		−0.002	−0.001
		(0.02)		(−0.37)	(−0.25)
WE			0.004	0.004	0.004
			(0.28)	(0.29)	(0.29)
China			−0.017	−0.017	−0.017
			(−1.57)	(−1.58)	(−1.61)
Intercept	−0.003	−0.002	−0.068	−0.070	−0.068
	(−0.60)	(−0.46)	(−1.34)	(−1.37)	(−1.34)
N	507	507	507	507	507
R^2	0.001	0.001	0.038	0.038	0.038

Notes: This table reports the estimates of the OLS regressions of abnormal stock returns around conventional bond announcements. The sample consists of 507 conventional bond issuance announcements. The dependent variable is the average *CAR* in the event window over −1 to 1 relative to the conventional bond announcement date (with the announcement date retrieved from SDC). The Appendix provides the variable definitions. *t*−statistics, based on robust standard errors, are in parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. N denotes the number of observations.

Table 11. Comparing regression coefficients across green and conventional bond stock price reactions

	Green *CAR*s	Conventional *CAR*s	χ^2−*statistic*	*p*−value
Trend	0.004	0.001	1.20	0.27
	(1.21)	(0.55)		
HHI	0.028	0.015	0.06	0.81
	(0.36)	(0.35)		
Tangibility	0.019*	−0.008	2.97*	0.09
	(1.96)	(−1.58)		
R&D	0.003**	−0.002	6.39**	0.01
	(2.11)	(−1.10)		
High-Tech	−0.015	0.012*	2.75*	0.09
	(−1.21)	(1.87)		
BTM	−0.004	0.005	0.76	0.38
	(−0.44)	(0.72)		
EScore	0.021*	−0.000	3.31*	0.07
	(1.67)	(−0.11)		
Advertising	0.155**	−0.036	6.55**	0.01
	(3.15)	(−1.03)		
ROA	0.000	0.001	1.04	0.31
	(0.11)	(0.81)		
Size	0.014**	0.005	0.66	0.42
	(2.11)	(0.78)		
Leverage	0.033	−0.016	2.50	0.11
	(1.10)	(−0.90)		
FirstGreenBond	0.008	0.036	−1.21	0.27
	(−1.35)	(−1.22)		
PriorConventional	0.017	0.002	1.64	0.20
	(1.43)	(0.37)		
IssueAmount	0.003	0.003	0.03	0.89
	(0.46)	(0.43)		
MoodyRating	−0.000	0.000	0.08	0.77
	(−0.72)	(0.18)		
Maturity	−0.000	−0.000	0.01	0.92
	(−0.68)	(−0.74)		
Financials	0.024**	−0.005	7.45***	0.01
	(2.09)	(−0.95)		
Utilities	0.001	0.007	0.09	0.76
	(0.06)	(0.95)		
WithdrawParis	−0.013	0.004	0.85	0.36
	(−1.01)	(0.67)		
COVID19	−0.012*	−0.001	2.26	0.13
	(−1.70)	(−0.25)		
WE	0.022	0.004	1.17	0.28
	(1.49)	(0.29)		
China	0.062**	−0.017	3.66*	0.06
	(2.02)	(−1.61)		
N	210	507	–	–
R^2	0.250	0.038	–	–

Notes: This table reports the coefficients in baseline regression between the two groups and reports chi-square for testing the difference between coefficients for green and conventional *CAR*s. The sample consists of 210 green bond announcements and 507 conventional bond announcements. We compare the difference of variables coefficients using χ^2−statistics. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% levels, respectively. N denotes the number of observations.

Appendix. Variable definition and sources

This Appendix provides detailed definitions and sources for the variables we use in the security choice analysis. We measure the issuer characteristics at the fiscal year end before the bond's issue date, unless noted otherwise. Data sources are mentioned in parentheses.

Variable	Definition and source
GreenBond	Dummy variable equal to one for bonds labeled as green bonds. [Bloomberg, SDC]
HHI	Measures industry concentration. It is calculated as the sum of squared market shares of all firms available on Worldscope with the same two−digit SIC industry code as the issuing firm. A firm's market share is the ratio of the firm's sales to the sum of sales for all firms in the same industry as the issuing firm. [Worldscope, SDC]
Tangibility	The ratio of net property, plant, and equipment to total assets. [Worldscope]
R&D	The ratio of R&D expenditure to total sales. Cases in which R&D expenses are missing are set to zero. [Worldscope]
High−Tech	Dummy variable equal to one when the firm is labeled as being in a high-technology industry. [Bloomberg, SDC]
BTM	The book value of equity scaled by the market value of equity. [Worldscope]
EScore	The logarithm of the firms' environmental performance score across three themes: emissions, environmental product innovation, and resource use. [Worldscope]
Advertising	The ratio of selling, advertising, and general expenses to total assets. [Worldscope]
ROA	The ratio of earnings before extraordinary items to total assets. [Worldscope]
Size	The logarithm of total assets. [Worldscope]
Leverage	The ratio of total liabilities to total assets. [Worldscope]
FirstGreenBond	Dummy variable equal to one if the firm issue green bonds for the first time during the sample period. [Bloomberg, SDC]
PriorConventional	Dummy variable equal to one if the firm issued conventional bonds previously during the sample period. [Bloomberg, SDC]
IssueAmount	The logarithm of the issue amount. [Bloomberg, SDC]
MoodyRating	Moody's rating of bonds. We convert Moody's rating into numerical values, with the highest number 21 given to the best rating of 'Aaa'. Cases in which Moody's rating are missing are set as the lowest level. [Bloomberg, SDC]
Rated	Dummy variable equal to one if the bond rating is available. [Bloomberg, SDC]
Maturity	The lifespan of a bond measured by year. [Bloomberg, SDC]
COVID19	Dummy variable equal to one if the firm issued bonds after February 1, 2020.
Industrials	Dummy variable equal to one for industrial firms, based on the firm's SIC code. [Bloomberg, SDC]
Financials	Dummy variable equal to one for financial firms, with SIC code between 6000 and 6999. [Bloomberg, SDC]
Utilities	Dummy variable equal to one for utility firms, with SIC code between 4900 and 4999. [Bloomberg, SDC]
US	Dummy variable equal to one if the bond issuer is domiciled in the US. [Bloomberg, SDC]
Western Europe	Dummy variable equal to one if the bond issuer is domiciled in Western Europe. [Bloomberg, SDC]
China	Dummy variable equal to one if the bond issuer is domiciled in China. [Bloomberg, SDC]
Trend	Announcement year of the green bond issuance minus year 2012 (e.g. The trend is labeled as 1 for bond issued in 2013).
WithdrawParis	Dummy variable equal to one if the firm issued bonds after 4 August, 2017.
EnvironmentalShock	Dummy variable equal to one for green bond issuance announced in the window [0, +300] following one of the external shocks, and zero for green bond issuance announced 300 days before one of two shocks (in the window [−300, 0])
WithdrawParisNarrow	Dummy variable equal to one for all green bond offerings made in narrow window 300 trading days before and after the US Paris Agreement Withdrawal.
COVID19Narrow	Dummy variable equal to one for all green bond offerings made in narrow window 300 trading days before and after the global outbreak of COVID-19.