Investors' reaction to greenwashing: Evidence in corporate ESG bond market

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Abstract

Based on negative correlations between CO_2 emissions and green bond issuance, existing literature concludes that greenwashing is inconsistent with green bond issuance. We re-examine the data and argue that greenwashing motive actually exists in the ESG bond markets, as some ESG bond issuers record fewer-than-expected environmental expenditure following their issuance of ESG bonds. The negligence of traditional institutional investors on environmental expenditure might encourage greenwashing behavior. Yet, we also find that some sophisticated investors penalize greenwashing by reducing capital invested to ESG bond issuers with fewer-than-expected environmental expenditure, irrespective of whether their environmental footprint has improved or not.

Keywords: ESG bonds, Greenwashing, Environmental Expenditure, Institutional Investors, Private Finance
JEL: G12, G23, G24, G30, M14

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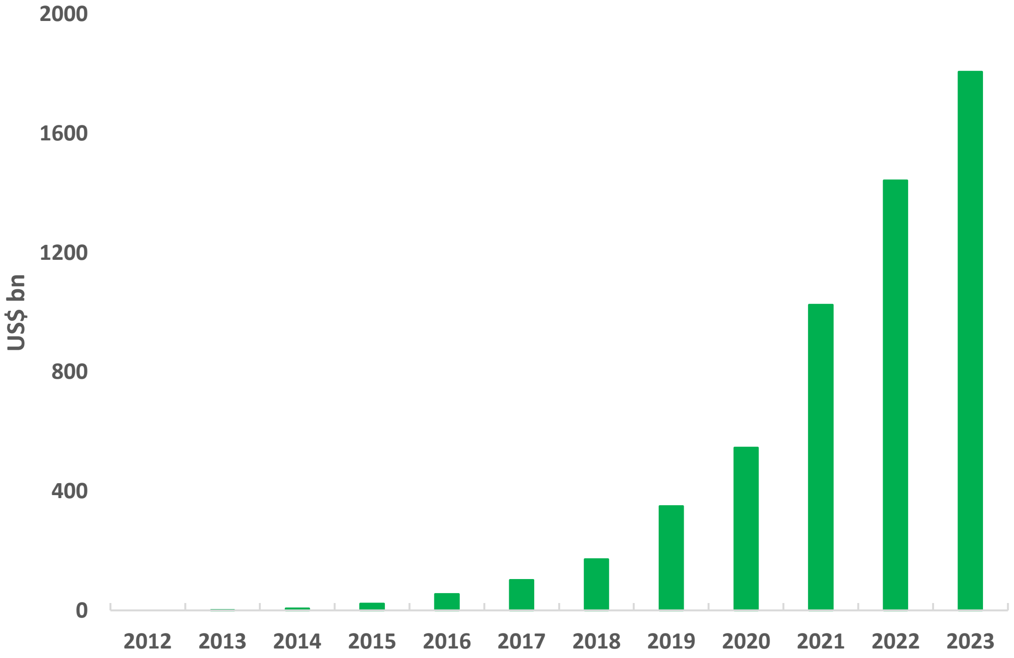
1. Introduction

Climate change has been recognized as the dominating risks on a global scale (World Economic Forum, 2024). To mitigate climate change, a large amount of climate finance is needed to facilitate firms to implement low-carbon transition. According to a recent study made by Climate Policy Initiative (Climate Policy Initiative, 2023), as of end-December 2022, climate finance must increase by at least five-fold annually to avoid the worse impacts of climate change. The urgent needs of climate finance also act as a wake-up call in the financial market. The corporate ESG bond market, pioneered by green bonds which are designated to fund green projects that aim to deliver environmental and climate benefits (Flammer, 2021; Lau et al., 2022), has grown rapidly since its inception and has been incorporating other dimensions of ESG considerations. Figure 1 depicts the size of global corporate ESG bond market in terms of outstanding of corporate ESG bonds over time. The figure shows that the corporate ESG bonds have been growing rapidly since 2012, the size of outstanding surged from less than US$1 billion in 2012-2013 to more than US$1.8 trillion in 2023. Relative to the global corporate bond outstanding (OECD, 2024), the outstanding of ESG bonds also increased from less than 0.01% in 2012-2013 to 5% in 2023.

Figure 1
Outstanding of corporate ESG bonds

This figure represents the total outstanding of corporate ESG bonds globally on an annual basis in the period from 2012 to 2023.



Source: Authors' calculation based on information from Refinitiv.

Along with the growth of ESG bond market is the fast-growing literature in this field. While early studies focused mainly on estimating the additional premium investors are willing to pay to invest in green bonds and generally found that investors are generally not willing to pay a premium investing in green bonds (Larcker and Watts, 2020) or just willing to pay a very small premium in it (Zerbib, 2019; Kanamura, 2020; Loffler et al., 2021; Pastor et al., 2022; Lau et al. 2022; Caramichael and Rapp, 2024), recent studies have started to investigate whether green bond can mitigate GHG emissions, or it is just a tool for greenwashing. Through evaluating the post-issuance environmental performance, such as change in CO_2 per book value in asset and environmental pillar score in Flammer (2021), change in total GHG emissions and direct GHG emissions in Fatica and Panzica (2021), change in GHG emission intensity in Leung et al. (2023), it is generally concluded that greenwashing motive is generally inconsistent with the green bond issuance, given that green bond issuers usually recorded improvements in environmental performance following their green bond issuance.

However, three substantial caveats exist in their argument. First is the sample construction. Due to the novelty of green bonds, most of the studies tried to maximize the sample size in their studies by including various types of green bonds. However, a bond classified as a green bond might not necessarily target at low-carbon transition. For instance, based on Climate Bonds Initiative (2021), a bond targeting at climate adaptation, such as flood defenses by constructing barriers and pumping stations, could be classified as a green bond; while a bond targeting at ecosystem protection by protecting habitat could also be classified as a green bond. With the presence of objective diversity, evaluating a green bond's performance based on changes in GHG emissions might not necessarily be appropriate. As such, for changes in GHG emissions to be a meaningful measure, a proper sample selection of ESG bonds is needed. To do so, we first compile a data set of ESG bonds from Refinitiv. The data set covers the universe of ESG bonds followed by Refinitiv that are issued by public and private firms globally from 2013 to 2023. Next, we exclude the ESG bonds if their goals were not aligned with the United Nations Sustainable Development Goal (UNSDG) 7: Affordable and clean energy or Goal 13: Climate action. As such, only ESG bonds targeting at GHG mitigation remain in our sample. Against this backdrop, the environmental performance of those bonds could be reasonably gauged by the issuer's GHG emissions performance.

The second caveat lies in the measure of greenwashing. Greenwashing, as also mentioned in Flammer (2021), refers to the practice of making unsubstantiated or misleading claims about the company's environmental commitment. In other words, whether a firm is classified as greenwashing should depends on whether it intended to exaggerated its effort put into creating positive climate impact. Unfortunately, both intention and efforts are hardly observable, existing studies thus adopt firm's environmental performance to proxy firm's effort in creating positive climate impact. Using the change in environmental performance as a yardstick, however, fails to conclude whether the firm has really made misleading claims on its environmental commitment. On the one hand, it is possible that a firm uses the proceeds of its ESG bond issued solely in other environmentally unrelated projects, while recording a reduction in GHG emissions due to the improvement in the national grid system. On the other hand, it is also possible that a firm did begin to implement its environmental R&D activities after its ESG bond issuance, yet it still records a higher GHG emissions if the R&D projects fail or require a longer time period to be effective. In these two examples, the latter will be classified as greenwashing while the former will not, both firms, however, should not be classified in such way. Therefore, using the environmental performance to measure greenwashing is improper and the implications based on improper measure might also be problematic. To empirically analyze greenwashing behavior, we propose using another measure, the change in environmental expenditure, to proxy firm's effort in creating positive climate impact. As a higher environmental expenditure truly implies that a firm is putting additional resources in creating positive climate impact, which is a better measure to gauge a firm's greenwashing motive compared to the change in environmental performance.

The third caveat relates to the issue of magnitude. Even if we accept the assumption that the environmental outcome could be a good measure of greenwashing, it is still hard to judge whether a firm recorded a higher GHG emission intensity should necessarily be classified as greenwashing. Existing literature classifies a firm as greenwashing if, holding other things equals, a firm records an increase in GHG emission intensity, irrespective of how large the incremental is. However, because the underlying economy and climate are non-stationary, the threshold of change in GHG emission intensity to be classified as greenwashing should also be non-stationary. For instance, a majority of firms recorded increase in GHG emission intensity after the post-COVID recovery. A firm with a negligible increase in GHG emission intensity might already have been outstanding compared to peers. Unfortunately, such firm would also be classified as greenwashing based on existing studies. To tackle this issue, we propose a more scientific method to first estimate firms' GHG emission intensity for each time period based on a battery of control variables, firm fixed-effects, country fixed-effects and year-month fixed effects, then classifies whether firm out-performs or under-performs by comparing the actual GHG emission intensity with its estimated value. We adopt the same methodology in gauging whether a firm out-performs or under-performs with respect to its environmental expenditure. By such means, we could classify whether a firm is a leader or laggard in terms of GHG mitigation and environmental expenditure.

Therefore, using proper proxy of greenwashing and sample of ESG bonds solely targeting at GHG mitigation, this paper seeks to push forward the literature by re-visiting the question on whether greenwashing motive really does not exist in the ESG bond market. We argue that some ESG bond issuers, despite having a lower GHG emission intensity, indeed greenwash, as reflected by having a lower-than-expected environmental expenditure after their issuance of ESG bonds, such measure is a proper measure as whether a firm overstates its environmental commitment should be judged by its environmental expenditure targeting at improving its environmental footprint, instead of the change of overall firm's environmental performance.

Besides, we also explore how investors react to potential greenwashing behavior. Existing studies show that events of green bond issuance of a firm could attract inflows from long-term investors (Flammer, 2021) and institutional investors (Tang and Zhang, 2020). We push forward the understanding of investors' investment strategies by investigating the evolution of ownership structure following the change in environmental performance as well as environmental expenditure. Sourced from Refinitiv, in line with existing literature, we find that institutional investors increase their holding on ESG bond issuers whose GHG emission intensity is lower-than-expected. This result is unsurprising as GHG emission is one of the most frequently use metrics for institutional investors to fulfill their green mandate. More importantly, we also find that those investments would keep their money sideline if the ESG bond issuers have an environmental expenditure that is higher-than-expected. These finding yield important policy implication as it seems that institutional investors might unintentionally encourage greenwashing behavior as they penalize firms who are willing to put more resources in improving their environmental footprint, ESG bond issuers, in order to attract more institutional clientele, might resort to reduce their environmental expenditure which would eventually be detrimental to low-carbon transition of the globe. As such, government and related regulatory authority might need to consider including environmental expenditure in the green mandates of financial institutions in their jurisdiction.

Apart from the traditional institutional investors, we also look at how private equity and venture capital (PEVC) investors react to ESG bond issuers' changes in environmental performance as well as environmental expenditure. Focusing on private investment of public equity deals and venture capital deals, compared to traditional institutional investors, PEVC investors are considered to be more sophisticated as the invested firms are generally in early stage. Besides, PEVC investors cannot sell their holdings quickly due until the lock up period is ended (Lim et al., 2021; World Economic Forum, 2023). As such, we expect PEVC investors, when making investment, might take a broader picture into consideration. Despite its relatively small size in absolute value, the growth of the market of PEVC has been rapid since 2018 (Wu and Chan, 2023; Cera et al., 2024). Furthermore, in the agenda of promoting sustainable investment among regulators and international organizations, the importance of PEVC has also been increasing (International Finance Corporation, 2018). As such, to explore this rapid growing segment, we sourced PEVC data from PitchBook and find that holding other things constant, when an ESG bond issuer increases its ESG bonds outstanding, the increase in total deal size raised by PEVC through private investment in public equity on average is largest for issuers with GHG emission intensity and environmental expenditure being both higher-than-expected, followed by issuers with GHG emission intensity being lower-than-expected while environmental expenditure being higher-than-expected. Interestingly, for ESG bond issuers having lower-than-expected environmental expenditure, there was no change in total deal size raised by PEVC on average for those having higher-than-expected GHG emission intensity. For ESG bond issuers with both lower-than-expected GHG emission intensity and environmental expenditure, total deal size raised by PEVC on average is even negative.

These combined finding suggest that some sophisticated PEVC investors might not just look at the post-issuance environmental performance, instead, they might take one step further by incorporating issuers' effort in improving environmental performance into their consideration. Those investors might increase the capital invested to an ESG bond issuer even if it recorded a relatively inferior environmental footprint, as long as evidence showing that efforts have been put to create positive climate impacts exist. Given that the size of private market is growing exponentially, ESG bond issuers should take the investment strategy of this part of segment of investors into consideration.

The remainder of this paper is organized as follows. Section 2 reviews the related literature, Section 3 describes the data and provides summary statistics, Section 4 discusses the results, and Section 5 concludes.

2. Related Literature

Our work is related to the literature on improvement of firm's environmental performance driven by green bond issuance. Existing studies strive to reveal a firm's greenwashing behavior by evaluating a firm's environmental performance after its green bond issuance. Using a sample of corporate green bonds in the world in the period 2013-2018, Flammer (2021) concludes that greenwashing motive did not prevail in the global corporate green bond market, evidenced by improved ASSET4 environmental rating and lower ratio of CO_2 emissions to book value of assets. Also evaluating the change in total CO_2 emissions and direct CO_2 emissions of a sample of nonfinancial corporations, Fatica and Panzica (2021) concludes that the finding of decrease in emissions after the firm's green bond issuance is inconsistent with the greenwashing argument. Comparing the average GHG emission intensity before and after green bond issuance in the globe, Leung et al. (2023) documented that greenwashing behavior prevails in global corporate green bond markets as some firms recorded increase in average GHG emission intensity after its green bond issuance. Garcia et al. (2023) argued that greenwashing exists in a sample of corporate green bonds issued globally in 2013-2019 as some green bond issuers recorded poorer environmental pillar scores. Existing studies also find that green bond issuance brings positive impact to its issuers from a broader sense of environmental performance. For example, Zhou and Cui (2019) show that the announcement of green bond issuance can improve the issuer's CSR score among a sample of Chinese listed companies; Fatica et al. (2021) document that financial institutions, after issuing green bonds, will shift lending away from carbon intensive sectors. Measured by ecological footprint comprising of carbon footprint, grazing lands, cropland, fishing grounds, forest lands, and built-up land, Chang et al. (2022) show that high green bond issuance is generally associated with an improved environmental quality at country level in a sample of 10 selected economies. Ordonez-Barrallo et al. (2023) also document a higher environmental pillar score after a firm issues green bond in a sample of 23 selected countries. Alamgir and Cheng (2023) document that green bond outstanding is negatively associated with per capita CO_2 and positively associated with per capita renewable energy production in a sample of 67 countries around the world.

Although the objective of green bonds is to finance environmentally friendly projects, not all green bonds target GHG emissions mitigation. As such, evaluating post-issuance environmental impact based on firms' GHG emissions might be improper. GHG emissions, however, are the most comprehensive and readily available environmental performance metrics nowadays. Therefore, to gauge the climate impact brought by ESG bonds issuance, we select the sample of ESG bonds with explicitly stated targets of UNSDGs 7: Affordable and clean energy or Goal 13: Climate action, which are directly related to GHG emissions mitigation.

Our work is also related to the literature on how investors react to a firm's environmental performance. Existing studies generally find that investors, especially institutional investors, tend to reduce holding stocks of firms with inferior environmental performance. Hartzmark and Sussman (2019) find that both institutional and retail investors are more willing to hold stocks of socially responsible firms. Dyck et al. (2019) show a positive relationship between institutional ownership and CSR. Nofsinger, Sulaeman, and Varma (2019) find that institutional investors underweight stocks with negative environmental and social indicators. Bolton and Kacperczyk (2021) show that institutional investors tend to divest from firms with higher Scope 1 emission intensity, primarily in high-emitting sectors. Pedersen, Fitzgibbons, and Pomorski (2021) document that institutional investors have incorporated a firm's environmental performance during portfolio formation. In particular, institutional ownership is negatively associated with CO_2 intensity. Choi et al. (2021) find that financial institutions reduced their exposure to stocks of companies in high-emission industries after 2015, especially for those in high-climate-awareness countries. Duan et al. (2023) show that institutional investors will divest from bonds issued by carbon-intensive firms. Chan and Wan (2024) show that institutional investors tend to divest from firms with higher emission intensity, and the divestment effect will be strengthened if the firms have declared their commitment to achieve net zero.

A few studies also tried to explore the linkage between institutional investors and green bond. For instance, Tang and Zhang (2020) show that institutional ownership, especially from domestic institutions, increases after the firm issues green bonds. Flammer (2021) documents that issuance of green bonds can attract long-term investors. Based on survey evidence, Sangiorgi and Schopohl (2021) reveal that European asset managers invest into green bonds due to green credentials adhered to green bonds while unclear and poor reporting are the main obstacles keeping their capitals sideline, indicating that greenwashing could obstruct green finance market development. We push forward this strand of literature by studying how greenwashing behavior, a major concern in the development of green finance market, affects investment decisions of institutional investors.

3. Data and Sample

Our primary database covers the period ranging from 2012 to 2023 and includes three datasets: Refinitiv, which provides information on corporate ESG bonds including the issuers, issue date, maturity date, size of issuance, currency denomination, as well as other green-specific indicators such as the types of ESG bonds (Green bonds, social bonds, sustainability-linked bonds), whether it has externally reviewed / second-party opinion, and its UNSDGs. Besides, Refinitiv also provides firm-level environmental expenditure at its ESG database, which is defined as all environmental investment & expenditures for environmental protection or to prevent, reduce, control environmental aspects, impacts, and hazards, which also includes disposal, treatment, sanitation, and clean-up expenditure. Furthermore, Refinitiv also provides information about holding of investors, including the investor name, the types of investors, as well as the amount of outstanding; PitchBook, which provides information on the transaction level for deals in private financing including private equity, venture capital, private debt, and merge and acquisition.[1] Complementary to the institutional investors data from Refinitiv, the information in private financing from PitchBook allows us to explore investor reactions in the alternative funding markets; and S&P Capital IQ, which provides data on firms' GHG emissions data and financial statements, such as balance sheets, income statements. Since our objective is to explore the impact of a firm's environmental expenditure on flows of institutional ownership, we exclude firms which are without information of environmental expenditure or ownership. We also exclude the ESG bonds that UNSDGs are neither Goal 7: Affordable and clean energy nor Goal 13: Climate action as we focus on studying ESG bonds targeting GHG emissions mitigation. Overall, our sample covers 669 green bonds issued from 179 firms globally, totaling US$223.5 billion of amount issued.

(a) Data on corporate green bonds

We sourced corporate ESG bonds data from Refinitiv. We extract all corporate bonds in Refinitiv's fixed income database that are labeled as "ESG bonds", i.e., bonds for which the field "ESG bonds" is "Yes". Given that Refinitiv has comprehensive coverage in its fixed income database, and it is also one of the prominent ESG rating agencies (Berg et al., 2022), the resulting dataset is likely to closely map the full universe of corporate ESG bonds. Focusing on climate change mitigation, we exclude the ESG bonds that UNSDGs are neither Goal 7: Affordable and clean energy nor Goal 13: Climate action. The above criteria yield a total of 7656 corporate ESG bonds issued from 2373 issuers in the period ranging from June 2012 to December 2023, totaling of US$2.0 trillion of amount issued.

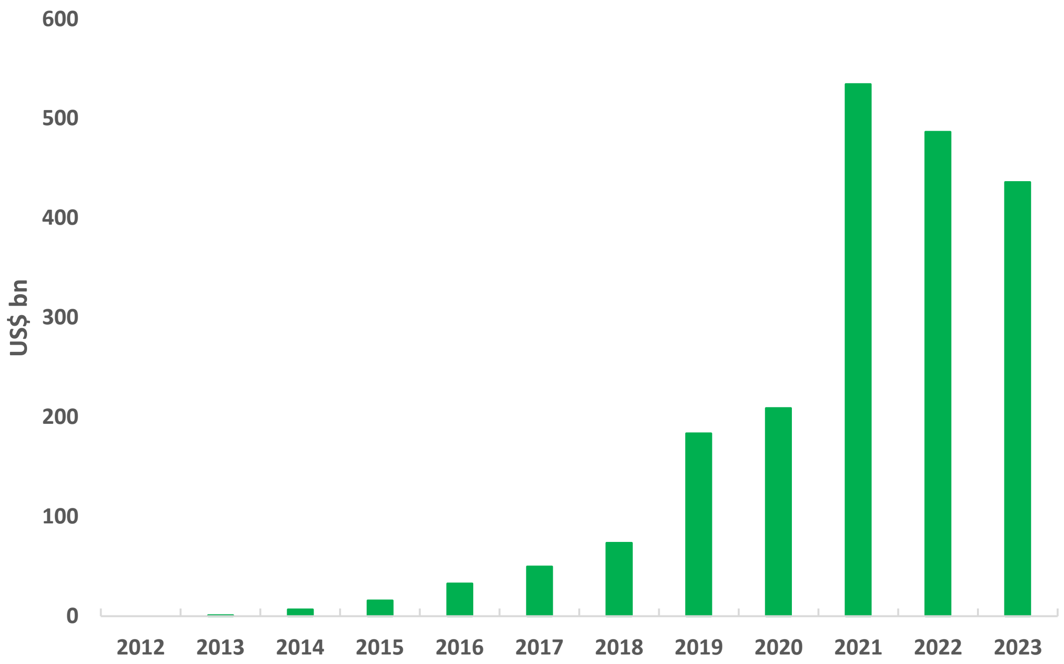
Having said that the growth of ESG bonds understanding has been rapid since its inception, a similar trend is also recorded in terms of new issuance. Figure 2 depicts the evolution of global corporate ESG bond new issuance. The new issuance skyrocketed from less than US$1bn in 2012-2013 to more than US$500bn in 2021. Although the year-on-year change in

[1] PitchBook's private financing data have been extensively used in prior studies on private financing among regulators (for example, Cai and Haque, 2024; Cera et al.,2024; International Monetary Fund, 2024) and academia (for example, Gompers et al.,2021; Ewens et al., 2022).

new issuance has turned negative in 2022 and 2023 amid the global rate hike, the size of new issuance in 2022 and 2023 still stayed more than double than that in 2020.

Figure 2
New issuance of corporate ESG bonds

This figure represents the total new issuance of corporate ESG bonds globally on an annual basis in the period from 2012 to 2023.



Source: Authors' calculation based on information from Refinitiv.

Table 1 reports a breakdown of corporate ESG bonds issuance by industries based on SIC 4-digit codes. Financials, including banking and investment companies, are the dominating ESG bonds issuers in the market. Among the industrials, corporate ESG bonds are dominated by electric and other services, followed by natural gas distribution, heavy construction, and motor vehicles and car bodies, in which its operation is highly related to environmental issues.

Table 1
Corporate ESG bonds by industry

This table reports the total number of corporate ESG bonds and total issuance amount (in US$ bn) by industry, using all corporate ESG bonds from 2012-2023. Industries are partitioned according to SIC 4-digit codes.

Industry	# bonds	US$ Amount (billion)
Financials	4419	1229.0
Banking	2089	648.5
Investment companies	1602	470.1
Real estate	567	76.4

Others	61	34.0
Industrials	3237	800.0
Electric and other services	1243	281.7
Natural gas distribution	45	25.5
Heavy construction	62	24.1
Motor vehicles and car bodies	52	21.9
Others	1835	456.8
Total	7656	2029.1

In terms of the issuer's nationality, Table 2 shows that corporate ESG bonds are dominated by the United States, China, and Europe including the Netherlands, France, and Germany.

Table 2
Corporate ESG bonds by country

This table reports the total number of corporate ESG bonds and total issuance amount (in US$ bn) by industry, using all corporate ESG bonds from 2012-2023. Countries are partitioned by issuer's nationality.

Country	# bonds	US$ Amount (billion)
United States	481	249.2
China	996	236.5
Netherlands	285	200.2
France	451	152.6
Germany	619	149.3
Japan	601	90.5
South Korea	542	80.8
United Kingdom	275	76.4
Italy	116	65.2
Spain	143	64.6
Canada	144	57.4
Sweden	573	56.2

Others	2429	550.3
Total	7656	2029.1

Table 3 provides the summary statistics on the 7656 corporate ESG bonds. On average, the issuance amount of corporate ESG bond is US$266 million, with 7 years' maturity. Average coupon rate is 3.36% with average option adjusted spread of 1.28%. Besides, ESG bonds are issued at a slight premium. Finally, almost 90% of the corporate ESG bonds were certified by an independent third party and more than 70% of the bonds were publicly-listed.

Table 3
Summary statistics on the 7656 corporate ESG bonds

This table reports summary statistics (averages, medians, and standard deviations) for all corporate ESG bonds. Amount (in US$ million) refers to the size of issuance in terms of US$ million. Maturity (in years) refers to the difference between the date of maturity and date of issuance. Option adjusted spread is the yield difference between the bond with the risk free rate, after adjusting the impact of option-embedded. Coupon (for fixed-rate bonds) refers to the annualized coupon rate offered by the bond. Issue price refers to the price of bond at the date of issuance. Certified (1/0) is a dummy variable equal to one if the ESG bond is certified by an independent third party.

Variables	Mean	Median	Std Dev
Amount (in US$ million)	266	106	365
Maturity (in years)	7.0	5.0	6.2
Coupon (for fixed-rate bonds)	3.36	3.05	3.43
Option adjusted spread (%)	1.28	0.96	3.93
Issue price	100.38	100.00	24.73
Certified (1/0)	0.86	1.00	0.12
Listed (1/0)	0.72	1.00	0.20

(b) Data on firm-level data

To evaluate firms' performance on GHG emissions mitigation, we sourced GHG emissions data from S&P Capital IQ. S&P Capital IQ collects firms' environmental data from a variety of publicly disclosed sources, such as annual reports, 10-K reports, SEC filings, CSR reports, sustainability reports, and ESG reports. In the absence of public disclosures, S&P Capital IQ provides data estimated using its environmentally extended input-output model. Following the GHG Protocol,[2] Trucost provided all three scopes of GHG emissions data. Scope 1emissions are from directly emitting sources owned or controlled by a company, such as the internal combustion engines of a trucking company. Scope 2 emissions are from the consumption of energy generated upstream from a company's direct operation, such as purchased electricity and steam. Scope 3 emissions cover all other emissions associated with

[2] See https://ghgprotocol.org/

a company's operations that are not directly owned or controlled by the company, including emissions in the company's supply chain and downstream. For the sake of comparison of carbon efficiency among firms, we adopted GHG emission intensities, GHG emissions normalized by a company's annual consolidated revenues, to evaluate firm's performance on GHG emissions mitigation. All three scopes are reported in units of tons of GHG emitted per millions of US dollars in a year. Since the three scopes of emissions capture different dimensions of emissions performance, to gain a more complete picture to gauge a firm's GHG performance, we use the aggregate of all three scopes of emissions to measure firm's total emissions.[3]

As mentioned previously, greenwashing behaviour should not be evaluated solely based on GHG performance, as it depends on whether the firm has genuinely spent additional resources trying to generate positive climate impact. As such, we collect data about firms' environmental expenditure from Refinitiv. Refinitiv is one of the few data providers that supplies the detailed underlying data points of their ESG scores, in which we can gather information regarding firm's environmental expenditure in the calculation of firm's environmental pillar score. Since we aim to explore the behaviour of firm's environmental expenditure due to its ESG bonds issuance, firms without data of environmental expenditure are excluded in the sample. As such, out of 7656 ESG bonds issued by 2373 issuers, 577 ESG bonds totalling with size US$187 billion issued by 179 issuers remains in our final sample.

We sourced other control variables from S&P Capital IQ. The vector of control variables include $LOGSIZE_{i,t}$, which is measured as the natural LOG scale of the market capitalization of firm i at the end of year t; $B/M_{i,t}$ which is measured as the book-to-market ratio of firm i at the end of year t; $LEVERAGE_{i,t}$, which is measured as the total debts divided by the total assets of firm i at the end of year t; $INVEST/A_{i,t}$, which is measured as firm i's capital expenditures divided by total assets at the end of year t; $HHI_{i,t}$, which is measured as the Herfindahl concentration index of firm i with respect to its industry based on each industry's revenues at the end of year t; $LOGPPE_{i,t}$, which is measured as the natural LOG scale of property, plant, and equipment of firm i at the end of year t; and $ROE_{i,t}$, which is measured as the net income divided by the total equity of firm i at the end of year t.

Finally, we sourced the information about investors from Refinitiv and PitchBook. Refinitiv tracks the monthly changes in equity ownership data, including the name of owner, types of owner, and amount of common stock held, such that we can evaluate how change in GHG emission intensity and environmental expenditure affects specific investor clienteles. PitchBook, a commercial data vendor specializing in private financing, collects information on the transaction level for deals including private equity, venture capital, private debt, and merge and acquisition. In our analysis, we focus on venture capital and private equity that involves changes in equity holding. To investigate the role of GHG emission intensity and environmental expenditure affecting capital raised by private equity and venture capital, the include all the deals whose invested firms are the ESG bond issuers in our sample.

Table 4 provides the summary statistics on the 179 ESG bond issuers. The average firm has a market capitalization of 11.38 trillion US dollars. The average book-to-market ratio and

[3] Because downstream Scope 3 emissions recently just started assembling in Trucost, the gaps in the data are numerous. As such, throughout our study, Scope 3 refers to upstream Scope 3. The same treatment was also adopted in Bolton and Kacperczyk (2021), Bolton and Kacperczyk (2023), Dai et al. (2024), Chan and Wan (2024).

leverage are 0.84 and 1.08, respectively. The average capital expenditure-to-asset ratio is 0.05. The average industry concentration ratio is 4.85%. The average firm has 5.44 trillion US dollars of property, plants, and equipment and has a ROE of 0.06. Finally, the average percentage of equity hold by institutional investors is 57%, while deal size of capital raised by PEVC investors is 344.35 million in US dollars, the median value of 0 indicates that capital raised by PEVC investors is not the main source of capital raising in the ESG bond markets.

Table 4
Summary statistics on the 179 ESG bond issuers

This table reports summary statistics (averages, medians, and standard deviations) for the ESG bond issuers in our sample. The sample period is from 2016 to 2022. $LOG\ GHG\ intensity$ refers to the natural LOG scale of the sum of Scope 1, Scope 2 and Scope 3 emission intensity; $LOG\ envir.expenditure$ is the natural local scale of the environmental expenditure; $LOGSIZE$ is the natural LOG scale of market capitalization; B/M is the book-to-market ratio; $LEVERAGE$ is the total debt to total asset ratio; $INVEST/A$ is the capital expenditure to total asset ratio; HHI is the Herfindahl index of a firm's industry with weights proportional to revenues; $LOGPPE$ is the natural LOG scale of property, plant and equipment; ROE is the ratio of net income to total equity; IO is the percentage of share owned by institutional investor; $Deal\ size^{PEVC}$ is the deal size raised from private equity or venture capital in terms of US$ million.

Variables	Mean	Median	Std Dev
$LOG\ GHG\ intensity$	6.02	6.04	1.20
$Environmental\ expenditure\ (US\$mn)$	207.06	31.78	557.91
$LOG\ SIZE$	9.34	9.38	1.25
B/M	0.84	0.73	0.57
$LEVERAGE$	1.08	0.16	3.69
$INVEST/A$	0.05	0.04	0.04
HHI (%)	4.85	4.22	2.72
$LOGPPE$	15.51	15.66	1.49
ROE	0.06	0.09	1.65
IO	0.57	0.57	0.18
$Deal\ size^{PEVC}\ (US\$million)$	344.35	0.00	2001.66

4. Results

We organize our discussion into two subsections. The first subsection examines the firm level outcomes in GHG emission intensity and environmental expenditure after the event of ESG bonds issuance. The second subsection explores investors' reactions towards changes in GHG emission intensity and environmental expenditure.

A. Firm-level outcomes and ESG bonds issuance

In this subsection, we present the evolution of firm-level outcomes in GHG emission intensity and environmental expenditure following the issuance of ESG bonds. We first describe the methodology, and then we present the results.

A.1. Empirical Specification on GHG emissions mitigation

Following Bolton and Kacperczyk (2023), we first evaluate how ESG bond issuance affect firm's GHG emission intensity by estimating the following regression equation:

$$LOG\ GHG\ intensity_{i,t} = \alpha_0 + \alpha_1 ESG\ bond_{i,t-1} + \alpha_2 Controls_{i,t-1} + \mu_{country} + \delta_{industry} + \gamma_t + \varepsilon_{i,t} \quad (1)$$

The dependent variable is $LOG\ GHG\ intensity_{i,t}$, the natural log of all summing all three scopes of GHG emission intensity for ESG bond issuer i at time t. $ESG\ bond_{i,t-1}$ is a generic term representing for dummy variable equals to 1 if firm i has positive outstanding of ESG bond at month $t-1$ and equals to 0 otherwise. It also represents for the natural LOG scale of one plus ESG bond outstanding of firm i at month $t-1$. The vector of firm-level controls includes the firm-level variables $LOGSIZE$, B/M, $LEVERAGE$, $INVEST/A$, HHI, $LOGPPE$, and ROE. All independent variables are lagged by 1 month. $\mu_{country}$, $\delta_{industry}$ and γ_t are country-fixed effects, industry-fixed effects, and year/month-fixed effects, respectively. Under this specification, equation (1) can be regarded as a determinants model of firm-level GHG emission intensity. Our coefficient of interest is α_1, it represents the impact of GHG emissions mitigation of ESG bonds.

A.2. Evidence on GHG emissions mitigation

Table 5 reports the estimation results of equation (1). The sample includes 9990 firm-month observations. Column (1) corresponds to the dummy variable of ESG bonds equals to 1 if the firm has positive outstanding of ESG bonds and 0 otherwise, while Column (2) corresponds to the natural LOG scale of one plus ESG bond outstanding. The coefficients of $ESG\ bonds$ are found to be both significantly negative in both columns, suggesting that firms recorded a lower GHG emission intensity after their ESG bond issuance. Specifically, Column (1) shows that on average, firms recorded a 10% reduction in GHG emission intensity after their ESG bonds issuance; while Column (2) shows that GHG emission intensity decreases by 0.01% for a 1% increase in ESG bond outstanding. These results are in line with existing literature that firms record an improvement in GHG emissions performance after their green bonds issuance.

Table 5
GHG emission intensity and ESG bonds

The sample period is from 2016 to 2022. The dependent variable is $LOG\ GHG\ intensity$. The main independent variables are dummy variable for having ESG outstanding (Column (1)) and LOG scale of ESG bond outstanding (Column (2)). All variables are defined in Tables 3 and 4. Standard errors are presented in parentheses. All regressions include year/month-fixed effects, country-fixed effects, and industry fixed-effects. *** 1% significance; ** 5% significance; * 10% significance.

Dependent Variables: $LOG\ GHG\ intensity$	(1) *ESG bonds:*	(2) *ESG bonds:*

	Dummy (Yes=1; No=0)	*LOG(1+Outstanding)*
ESG bonds	-0.10***	-0.01***
	(0.01)	(0.00)
LOG SIZE	-0.33***	-0.33***
	(0.01)	(0.01)
B/M	-0.02***	-0.02***
	(0.00)	(0.00)
LEVERAGE	-0.06***	-0.06***
	(0.00)	(0.00)
ROE	-0.00	-0.00
	(0.00)	(0.00)
INVEST/A	-0.01***	-0.01***
	(0.00)	(0.00)
HHI	-0.01**	-0.01**
	(0.01)	(0.00)
LOG PPE	0.28***	0.28***
	(0.01)	(0.01)
Year/month-fixed effects	Yes	Yes
Country-fixed effects	Yes	Yes
Industry-fixed effects	Yes	Yes
Observations	9990	9990
R-square	0.9135	0.9136

A.3. Empirical Specification on environmental expenditure

Having said judging whether a firm greenwashes based on its GHG emissions performance is improper. Next, we explore how ESG bond issuance affect firm's environmental expenditure by estimating the following regression equation:

$$LOG\left(1 + envir.expenditure_{i,t}\right) = \alpha_0 + \alpha_1 ESG\ bond_{i,t-1} + \alpha_2 Controls_{i,t-1} + \mu_{country} + \delta_{industry} + \gamma_t + \varepsilon_{i,t} \quad (2)$$

The dependent variable is $LOG\left(1 + envir.expenditure_{i,t}\right)$, the natural log of one plus environmental expenditure of ESG bond issuer i at time t. The independent variable

$ESG\ bond_{i,t-1}$ and the vector of firm-level controls includes the firm-level variables $LOGSIZE$, B/M, $LEVERAGE$, $INVEST/A$, HHI, $LOGPPE$, and ROE are same as the equation (1). All independent variables are lagged by 1 month. $\mu_{country}$, $\delta_{industry}$ and γ_t are country-fixed effects, industry-fixed effects, and year/month-fixed effects, respectively. Under this specification, equation (2) can be regarded as a determinants model of firm-level environmental expenditure. Our coefficient of interest is α_1, it represents the impact of firm's environmental expenditure of ESG bonds.

A.4. Evidence on environmental expenditure

Table 6 reports the estimation results of equation (2). Both Columns (1) and (2) report a significantly positive coefficient of $ESG\ bonds$, indicating that firms, on average, tend to increase their environmental expenditure after their ESG bond issuance. Specifically, Column (1) shows that on average, firms increased environmental expenditure by 40% after their ESG bonds issuance; while Column (2) shows that environmental expenditure increases by 0.02% for a 1% increase in ESG bond outstanding. These results indicate that on average, firms do put more resources into improving their environmental performance, implying that greenwashing is not a dominating motive for ESG bond issuance.

Table 6
Environmental expenditure and ESG bonds

The sample period is from 2016 to 2022. The dependent variable is $LOG\ (1 + envir\ exp)$. The main independent variables are dummy variable for having ESG outstanding (Column (1)) and LOG scale of ESG bond outstanding (Column (2)). All variables are defined in Tables 3 and 4. Standard errors are presented in parentheses. All regressions include year/month-fixed effects, country-fixed effects, and industry fixed-effects. *** 1% significance; ** 5% significance; * 10% significance.

Dependent Variables: $LOG\ (1 + envir.expenditure)$	(1) *ESG bonds:* *Dummy (Yes=1; No=0)*	(2) *ESG bonds:* *LOG(1+Outstanding)*
ESG bonds	0.40***	0.02***
	(0.07)	(0.00)
LOG SIZE	0.03	0.03
	(0.04)	(0.04)
B/M	0.08***	0.08***
	(0.01)	(0.01)
LEVERAGE	-0.11***	-0.11***
	(0.01)	(0.01)
ROE	0.01	0.01
	(0.01)	(0.01)
INVEST/A	0.08***	-0.08***
	(0.01)	(0.01)

HHI	-0.02	-0.02
	(0.03)	(0.03)
LOG PPE	0.70***	0.70***
	(0.04)	(0.04)
Year/month-fixed effects	Yes	Yes
Country-fixed effects	Yes	Yes
Industry-fixed effects	Yes	Yes
Observations	9990	9990
R-square	0.728	0.728

Although the estimation results indicate that ESG bond issuers generally recorded a reduction in GHG emission intensity and an increase in environmental expenditure, we cannot rule out the possibility that some issuers recorded an increase in GHG emission intensity or reduced their environmental expenditure. Next, we will explore how institutional investors react to those firms.

B. Investors' reactions to change in GHG emission intensity and environmental expenditure

In this subsection, we first describe the methodology to evaluate whether firms out-perform or under-perform with respect to GHG emission mitigation and environmental expenditure following their ESG bond issuance, and then present how investors react differently on different performance.

B.1. Methodology

To identify whether firms out-perform or under-perform in GHG emission mitigation, we first compute the estimated GHG emission intensity of each firm i at each time t using Equation (1), based on the estimated coefficients by panel data fixed effects estimation.[4] By such means, we can identify whether the firm i at time t has a GHG emission intensity above the estimated when actual GHG emission intensity is higher than estimated GHG emission intensity, or below the estimated when actual GHG emission intensity is lower than estimated GHG emission intensity. We define the former as GHG mitigation leaders and the latter as GHG mitigation laggards, during the period when the firm i has a positive outstanding of ESG bonds at time t.

Table 7 reports the characteristics of GHG mitigation leaders and laggards. Compared to GHG mitigation laggards, unsurprisingly, the average GHG emission intensity among the GHG mitigation leaders is smaller. We also note that the average size of ESG bonds outstanding for GHG mitigation leaders is larger. The combined findings of larger ESG bonds outstanding and smaller GHG emission intensity are in line with a positive link

[4] Given a slightly higher adjusted R-square, continuous ESG bonds outstanding will be used to estimate the expected GHG emission intensity.

between green bonds issuance and environmental performance found in existing literature. Interestingly, compared to GHG mitigation leaders, the average size of environmental expenditure among GHG mitigation laggards is larger, which indicates that gauging greenwashing motive solely based on post-issuance environmental performance might be improper, given that some firms, despite having a relatively inferior current environmental performance after ESG bonds issuance, they indeed have put more resources in environmental conservation, which is inconsistent with the definition of greenwashing.

Furthermore, GHG mitigation laggards have a larger size but smaller fixed assets. They also have a larger leverage and ROE, which might indicate that they focus more on profit growth than GHG mitigation. Finally, the ratio of salient industry is larger for GHG mitigation laggards than that for GHG mitigation leaders.

Table 7
GHG mitigation leaders/laggards

This table covers the sample of observations with GHG mitigation leaders/laggards and reports the sample means of observations during 2016-2022. Most variables are defined in Table 3 and 4. $Salient\ industry\ (1/0)$ is a dummy variable if the issuer is an energy/utility company.

	(1) $GHG\ mitigation\ leaders$	(2) $GHG\ mitigation\ laggards$
$LOG\ GHG\ intensity$	5.63	6.01
ESG bonds outstanding (US$mn)	733.8	508.2
$Environmental\ expenditure\ (US\$mn)$	189.3	218.1
LOG SIZE	9.31	9.42
B/M	0.951	0.841
LEVERAGE	1.801	2.347
ROE	0.102	0.124
INVEST/A	0.050	0.049
HHI	0.044	0.046
LOG PPE	15.521	15.377
Salient industry (1/0)	0.238	0.284
Observations	1390	867

Similarly, to identify whether a firm out-perform or under-perform in environmental expenditure, we first compute the estimated environmental expenditure of each firm i at each time t using Equation (2), using the estimated coefficients by panel data fixed effects estimation.[5] As such, we can identify whether the firm i at time t has an environmental expenditure above the estimated when actual environmental expenditure is higher than estimated environmental expenditure or below the estimated when actual environmental expenditure is lower than estimated environmental expenditure. We define the former as

[5] Given a slightly higher adjusted R-square, continuous ESG bonds outstanding will be used to estimate the expected environmental expenditure.

environment leaders and the latter as environment laggards, during the period when the firm i has a positive outstanding of ESG bonds at time t.

Table 8 reports the characteristics of environment leaders and laggards. We note that while the GHG emission intensity between two groups are similar, the size of ESG bonds outstanding for environment laggards is on average 13% smaller than that of environment leaders, and the environmental expenditure of the former is on average 71% smaller than that of the latter. This significant difference might suggest that despite having a higher-than-expected GHG emission intensity, environmental expenditures leaders have indeed put more-than-expected resources trying to improve their environmental performance, such efforts should not be omitted, and they should not be classified as a greenwashing ESG bond issuer.

Furthermore, we notice that environment leaders generally have a smaller book-to-market ratio, smaller industry concentration and a higher coverage of salient industry.

Table 8
Environment leaders/laggards

This table covers the sample of observations with environment leaders/laggards and reports the sample means of observations during 2016-2022. Most variables are defined in Table 3 and 4. $Salient\ industry\ (1/0)$ is a dummy variable if the issuer is an energy/utility company.

	(1) $Environment\ leaders$	(2) $Environment\ laggards$
$LOG\ GHG\ intensity$	5.83	5.74
ESG bonds outstanding (US$mn)	718.4	626.1
$Environmental\ expenditure$ *(US$mn)*	311.4	91.4
LOG SIZE	9.37	9.33
B/M	0.884	0.933
LEVERAGE	1.975	2.046
ROE	0.119	0.102
INVEST/A	0.050	0.049
HHI	0.040	0.050
LOG PPE	15.515	15.417
Salient industry (1/0)	0.286	0.226
Observations	1118	1139

Finally, we report summary statistics on the main determinants of GHG mitigation leaders/laggards and environment leaders/laggards in Table 9 on a firm’s ESG bond outstanding data, GHG emission intensity data, environmental expenditure data and other firm-level characteristics. Year/month-fixed effects, country-fixed effects and industry-fixed effects are also included to capture the differences across countries and industries over time.

The multinomial logit model is adopted in which firms belong to GHG mitigation leaders and environmental expenditure leaders are selected as the benchmark.[6]

Table 9
Predictors of GHG mitigation leaders/laggards and environmental expenditure leaders/laggards

The sample period is from 2016 to 2022. The dependent variable is outcome variable of whether an ESG bond issuer is a/an GHG mitigation leader/laggard and environmental expenditure leader/laggard. Columns (1), (2) and (3) represent the coefficient for outcome equals to GHG mitigation leaders and environmental expenditure laggards, GHG mitigation laggards and environmental expenditure leaders, and GHG mitigation laggards and environmental expenditure laggards, respectively. All variables are defined in Tables 3 and 4. Standard errors are presented in parentheses. All regressions include year/month-fixed effects, country-fixed effects, and industry fixed-effects. *** 1% significance; ** 5% significance; * 10% significance.

Benchmark: GHG mitigation leaders and environmental expenditure leaders	(1) GHG mitigation leaders and environmental expenditure laggards	(2) GHG mitigation laggards and environmental expenditure leaders	(3) GHG mitigation laggards and environmental expenditure laggards
LOG GHG intensity	-23.65***	35.53***	36.84***
	(3.02)	(1.76)	(4.19)
LOG (1+envir exp)	-18.08***	6.19***	-18.01***
	(1.70)	(1.76)	(1.37)
LOG(ESG bond outstanding)	5.63***	-4.84***	5.13***
	(1.99)	(1.68)	(1.93)
LOG SIZE	-19.46***	19.04***	19.77***
	(4.40)	(3.78)	(4.87)
B/M	0.83	0.07	3.14***
	(0.63)	(0.45)	(0.59)
LEVERAGE	0.78	7.86***	3.02***
	(0.60)	(0.51)	(0.75)
ROE	44.47***	62.18***	9.55
	(10.16)	(11.20)	(10.10)
INVEST/A	3.28***	0.79**	7.63***
	(0.51)	(0.42)	(0.43)
HHI	0.36	-4.69***	1.66
	(0.65)	(2.05)	(1.78)
LOG PPE	30.15***	-21.09***	-16.59***
	(3.99)	(4.15)	(4.31)

[6] Multinomial logit model is useful where the dependent variable (unordered response) has more than two outcomes (Wooldridge (2001)).

Year/month-fixed effects	Yes	Yes	Yes
Country-fixed effects	Yes	Yes	Yes
Industry-fixed effects	Yes	Yes	Yes
Observations	2257	2257	2257

Unsurprisingly, we note that GHG mitigation laggards have a higher GHG emission intensity while environmental expenditure laggards have a lower environmental expenditure. Comparing among four groups, we find that environment laggards have a larger ESG bond outstanding but a smaller environmental expenditure, indicating that some large ESG bond issuers will not map their ESG bond proceeds to environmental expenditure. We also note that GHG mitigation laggards are significantly larger in size, having a higher leverage, and having smaller fixed assets, indicating that firms with smaller size but having more fixed assets are more efficient in decarbonisation. For environmental expenditure laggards, it is commonly found that they have a larger capital investment to asset, as such the environmental expenditure might be crowded out.

B.2. Empirical specification on institutional investors

Existing studies show that there is an increase in equity holding from institutional investors if the firm recorded improvement in environmental performance, recent studies also show institutional ownership increases if the firm issue green bonds. However, whether there are change in behavior in institutional ownership with respect to GHG emission intensity and environmental expenditure after the firms issue ESG bonds remains unexplored. Sophisticated and environmentally conscious investors might shun companies with increased GHG emission intensity and/or decreased environmental expenditure due to their green preference.

As such, we test this possibility by looking at the portfolio holdings of institutional investors. Formally, we estimate the following regression model:

$$\begin{aligned} IO_{i,t} = \alpha_0 &+ \alpha_1 LOG\ (ESG\ bonds\ outstanding_{i,t-1}) + \alpha_2 D_{i,t-1}^{GHG\ mitigation\ leader} \\ &+ \alpha_3 D_{i,t-1}^{Environment\ leader} \\ &+ \alpha_4 \left(D_{i,t-1}^{GHG\ mitigation\ leader} \times \mathrm{LOG}\ (ESG\ bonds\ outstanding_{i,t-1})\right) \\ &+ \alpha_5 \left(D_{i,t-1}^{Environment\ leader} \times \mathrm{LOG}\ (ESG\ bonds\ outstanding_{i,t-1})\right) \\ &+ \alpha_6 Controls_{i,t-1} + \mu_{country} + \delta_{industry} + \gamma_t + \varepsilon_{i,t} \end{aligned} \tag{3}$$

The dependent variable is $IO_{i,t}$, representing the fraction of the shares of ESG bond issuer i held by institutional investors at time t. The independent variable the natural LOG of ESG bond outstanding, $D_{i,t-1}^{GHG\ mitigation\ leader}$, a dummy variable equals to 1 if firm i is classified as GHG mitigation leader at time $t-1$ and equals to 0 otherwise, $D_{i,t-1}^{Environment\ leader}$, a dummy variable equals to 1 if firm i is classified as environment leader at time $t-1$ and equals to 0 otherwise. All independent variables are lagged by 1 month. $\mu_{country}$, $\delta_{industry}$ and γ_t are country-fixed effects, industry-fixed effects, and year/month-fixed effects, respectively.

Under this specification, when the ESG bond issuers increase the ESG bond size, the subsequent change in the institutional ownership would depend on whether the firm is classified as GHG mitigation leader/laggard and environment leader/laggard. Formally, for a 1% increase in ESG bonds outstanding, the change in institutional ownership is captured by $\alpha_1 + \alpha_4\left(D_{i,t-1}^{GHG\ mitigation\ leader}\right) + \alpha_5(D_{i,t-1}^{Environment\ leader})$.

B.3. Evidence on institutional investors

Table 10 reports the estimation result of Equation (3). Column (1) reports the estimation results with the exclusion of dummy variables of GHG mitigation leader/laggard, environment leader/laggard, as well as their interaction term with ESG bonds outstanding. The estimated coefficient of *LOG(ESG bond outstanding)* is marginally positive, indicating that increase in ESG bond outstanding on average could attract inflows of institutional investors, which is in line with existing findings that issuance of green bond could result in higher institutional ownership.

Column (2) reports the estimation results with the inclusion of dummy variables of GHG mitigation leader/laggard and environment leader/laggard, as well as the interaction between dummies and *LOG(ESG bond outstanding)*. Holding other things constant, the estimated change in institutional ownership with respect to a 1% increase in ESG bonds outstanding equals to $1.6\%\left(D_{i,t-1}^{GHG\ mitigation\ leader}\right) - 0.98\%(D_{i,t-1}^{Envir\ exp\ leader})$. As such, when a firm increases its ESG bond outstanding, the increase in institutional ownership would be highest if the firm is classified as GHG mitigation leaders and environment laggards, followed by GHG mitigation leaders and environment leaders. The negative coefficient of $D_{i,t-1}^{Envir\ exp\ leader}$ might also encourage greenwashing behavior among ESG bond issuers as it implies that institutional investors would penalize ESG bond issuers who put more-than-expected resources in improving environmental footprint.

Change in institutional ownership associated with an increase in ESG bond issuance would be negative if the issuer is classified as GHG mitigation laggards, the decrease will be even larger if the issuer is also classified as environment leader. The result is unsurprising as institutional investors, apart from focusing on returns maximization which might regarding excessive environmental expenditure as a waste of resources, fulfil their green mandates based mainly on the GHG emissions metrics associated with their investment portfolio. Therefore, ESG bond issuers who have lower GHG emission intensity and environmental expenditure could attract more institutional investors.

Table 10
ESG bonds and institutional investors

The sample period is from 2016 to 2022. The dependent variable is $IO_{i,t}$. The main independent variables are LOG(ESG bond outstanding) (Column (1)), as well as $D_{i,t-1}^{GHG\ mitigation\ leader}$, a dummy variable equals to 1 if firm i is classified as GHG mitigation leader at time $t-1$ and equals to 0 otherwise, $D_{i,t-1}^{Envir\ exp\ leader}$, a dummy variable equals to 1 if firm i is classified as environment leader at time $t-1$ and equals to 0 otherwise (Column (2)). All other variables are defined in Tables 3 and 4. Standard errors are presented in parentheses. All regressions include year/month-fixed effects, country-fixed effects, and industry fixed-effects. *** 1% significance; ** 5% significance; * 10% significance.

Dependent Variables: $IO_{i,t}(\%)$	(1)	(2)
LOG(ESG bond outstanding)	0.60*	0.21
	(0.33)	(0.41)
		(0.07)
$D^{GHG\ mitigation\ leader}$		-32.86***
		(6.31)
$D^{Env\ exp\ leader}$		18.88***
		(7.29)
LOG(ESG bond outstanding)$\times D^{GHG\ mitigation\ leader}$		1.60***
		(0.32)
LOG(ESG bond outstanding)$\times D^{Environment\ leader}$		-0.98***
		(0.37)
LOG SIZE	-5.76***	-5.78***
	(0.45)	(0.47)
B/M	-0.64***	-0.62
	(0.05)	(0.05)
LEVERAGE	0.40***	0.34***
	(0.07)	(0.07)
ROE	0.09***	0.11***
	(0.02)	(0.02)
INVEST/A	-0.17***	-0.21***
	(0.08)	(0.08)
HHI	-0.56***	-0.58***
	(0.16)	(0.16)
LOG PPE	3.65***	3.86***
	(0.38)	(0.39)
Year/month-fixed effects	Yes	Yes
Country-fixed effects	Yes	Yes
Industry-fixed effects	Yes	Yes
Observations	2256	2256
R-square	0.8160	0.8682

B.4. Empirical specification on PEVC investors

Apart from the traditional institutional investors, we also look at how PEVC investors react to ESG bond issuers' changes in environmental performance as well as environmental expenditure.

$$
\begin{aligned}
LOG\ (1 + Deal\ Size_{i,t}^{PEVC}) \\
&= \alpha_0 + \alpha_1 LOG\ (ESG\ bonds\ outstanding_{i,t-1}) \\
&+ \alpha_2 D_{i,t-1}^{GHG\ mitigation\ leader} + \alpha_3 D_{i,t-1}^{Environment\ leader} \\
&+ \alpha_4 \left(D_{i,t-1}^{GHG\ mitigation\ leader} \times \mathrm{LOG}\ (ESG\ bonds\ outstanding_{i,t-1})\right) \\
&+ \alpha_5 \left(D_{i,t-1}^{Environment\ leader} \times \mathrm{LOG}\ (ESG\ bonds\ outstanding_{i,t-1})\right) \\
&+ \alpha_6 Controls_{i,t-1} + \mu_{country} + \delta_{industry} + \gamma_t + \varepsilon_{i,t}
\end{aligned}
\tag{4}
$$

The dependent variable is $\mathrm{LOG}\,(1 + Deal\ Size_{i,t}^{PEVC})$, which is defined at Table 4. The independent variable includes the natural LOG of ESG bond outstanding, $D_{i,t-1}^{GHG\ mitigation\ leader}$, $D_{i,t-1}^{Environment\ leader}$, and other control variables are same as Equation (3). Similarly, all independent variables are lagged by 1 month. $\mu_{country}$, $\delta_{industry}$ and γ_t are country-fixed effects, industry-fixed effects, and year/month-fixed effects, respectively.

Under this specification, when the ESG bond issuers increase the ESG bond size, the subsequent change in average deal size would depend on whether the firm is classified as GHG mitigation leader/laggard and environment leader/laggard. Formally, for a 1% increase in ESG bonds outstanding, the change in average deal size is captured by $\alpha_1 + \alpha_4\left(D_{i,t-1}^{GHG\ mitigation\ leader}\right) + \alpha_5(D_{i,t-1}^{Environment\ leader})$.

B.5. Evidence on PEVC investors

Table 11 reports the estimation result of Equation (4). Column (1) reports the estimation results with the exclusion of dummy variables of GHG mitigation leader/laggard, environment leader/laggard, as well as their interaction term with ESG bonds outstanding. The estimated coefficient of *LOG(ESG bond outstanding)* is statistically insignificant, indicating that increase in ESG bond outstanding on average has no impact on inflows from PEVC investors.

Column (2) reports the estimation results with the inclusion of dummy variables of GHG mitigation leader/laggard and environment leader/laggard, as well as the interaction between dummies and *LOG(ESG bond outstanding).* Holding other things constant, the estimated change in deal size with respect to a 1% increase in ESG bonds outstanding equals to $-0.21\% - 0.17\%\left(D_{i,t-1}^{GHG\ mitigation\ leader}\right) + 0.41\%(D_{i,t-1}^{Envir\ exp\ leader})$. In other words, the estimated deal size will increase following the increase in ESG bond outstanding only if the ESG bond issuers are environment leaders, in which the estimated deal size will increase by 0.20% if the issuers are GHG mitigation laggards and 0.04% if the issuers are GHG mitigation leaders. The larger increase among GHG mitigation laggards might suggest that PEVC investors expect the stronger additionality effect could bring them a larger value-added in the future. As such, even if the ESG bond issuers are currently GHG mitigation laggards, the higher-than-expected environmental expenditure could convince them that the issuers are implementing low-carbon transition, the expected positive value-added thus incentivize them to increase their funds invested into the ESG bond issuers.

Table 11
ESG bonds and PEVC investors

The sample period is from 2016 to 2022. The dependent variable is LOG $(1 + Deal\ Size_{i,t}^{PEVC})$. The main independent variables are LOG(ESG bond outstanding) (Column (1)), as well as $D_{i,t-1}^{GHG\ mitigation\ leader}$, a dummy variable equals to 1 if firm i is classified as GHG mitigation leader at time $t-1$ and equals to 0 otherwise, $D_{i,t-1}^{Envir\ exp\ leader}$, a dummy variable equals to 1 if firm i is classified as environment leader at time $t-1$ and equals to 0 otherwise (Column (2)). All other variables are defined in Tables 3 and 4. Standard errors are presented in parentheses. All regressions include year/month-fixed effects, country-fixed effects, and industry fixed-effects. *** 1% significance; ** 5% significance; * 10% significance.

Dependent Variables: LOG $(1 + Deal\ Size_{i,t}^{PEVC})$	(1)	(2)
LOG(ESG bond outstanding)	-0.02	-0.21***
	(0.06)	(0.07)
$D^{GHG\ mitigation\ leader}$		2.96***
		(0.98)
$D^{Env\ exp\ leader}$		-8.58***
		(1.11)
LOG(ESG bond outstanding)× $D^{GHG\ mitigation\ leader}$		-0.17***
		(0.05)
LOG(ESG bond outstanding)× $D^{Environment\ leader}$		0.41***
		(0.06)
LOG SIZE	1.10***	0.87***
	(0.08)	(0.08)
B/M	0.05***	0.02
	(0.01)	(0.01)
LEVERAGE	0.15***	0.18***
	(0.01)	(0.01)
ROE	-0.01	0.13
	(0.03)	(0.29)
INVEST/A	0.13***	0.12***
	(0.01)	(0.01)
HHI	-0.24**	-0.20***
	(0.06)	(0.06)
LOG PPE	-0.84***	-0.73***
	(0.07)	(0.07)
Year/month-fixed effects	Yes	Yes

Country-fixed effects	Yes	Yes
Industry-fixed effects	Yes	Yes
Observations	2256	2256
R-square	0.8012	0.8127

In contrast, the estimated deal size will decrease following the increase in ESG bond outstanding if the ESG bond issuers are environment laggards. Specifically, the estimated deal size will drop by 0.21% for GHG mitigation laggards and 0.38% for GHG mitigation leaders. These results show that PEVC investors tend to reduce their investment towards ESG bond issuers whose spend fewer-than-expected in environmental expenditure, suggesting that PEVC investors might penalize greenwashing behavior from the ESG bond issuers, irrespective of whether the issuers are GHG mitigation leaders or laggards.

These findings yield important implications to ESG bond issuers. ESG bond issuers should not regard ESG bonds as a greenwashing tool, given that investors would take environmental expenditure into consideration with respect to firms having ESG bond outstanding. ESG bond issuers who are not willing to increase their corresponding environmental expenditure might eventually find it harder to acquire funding in the financial market. From the policy-maker's perspective, ESG bond issuers' environmental expenditure has to be monitored, as otherwise a smaller size of capital raised might transform into a higher cost of funding, which might eventually be slowing down the development of financial market.

5. Conclusion

The facts speak for themselves. If ESG bonds bring no positive climate impact, they would not have been regarded as an important tool by regulators in promoting sustainable development. Leveraging on multiple data sources, we have shown that ESG bond issuers lower their GHG emission intensity on average following the issuance of ESG bonds, indicating that ESG bonds could facilitate firms to achieve low-carbon transition. We also show that higher ESG bond outstanding is also associated with a higher firm's environmental expenditure on average, suggesting that firms tend to put more resources to improve their environmental footprint following the issuance of ESG bonds. These findings are in line with existing literature that greenwashing does not represent the dominating motive in the green finance market. Yet, the negative coefficient between GHG emission intensity and ESG bond outstanding, as well as the positive coefficient between environmental expenditure and ESG bond outstanding, just indicates the average market behavior, the possibility that some firms record a deterioration in environmental footprint and/or greenwash by spending less on environmental issues cannot be ruled out.

By classifying ESG bond issuers into GHG mitigation leaders/laggards and environment leaders/laggards, we find that some ESG bond issuers, despite issuing a larger amount of ESG bonds, their environmental expenditure turns out to be smaller than that of issuers who have a smaller ESG bond outstanding, suggesting that some ESG bond issuers might not necessarily spend their ESG bond proceeds raised into improving their environmental footprint, which is consistent with the greenwashing motive. We also find that some ESG bond issuers; despite having a higher-than-expected GHG emission intensity, they did put more capital in environmental expenditure. While these firms are classified as greenwash in existing literature, the increase in environmental expenditure suggests the opposite.

Regarding the investors' reaction towards ESG bond issuers' behavior in environmental footprint and environmental expenditure, we find that traditional institutional investors tend to invest to ESG bond issuers who have superior environmental footprint while keeping their money sideline if the issuers have unexpectedly large environmental expenditure. This might encourage ESG bond issuers to greenwash as lowering environmental expenditure could attract a higher institutional ownership. This finding yield important policy implications that apart from environmental footprint, government might consider including environment expenditure or resources put into improving firms' environmental performance into institutional investors' investment mandates, as decreasing environment expenditure might hinder the low-carbon transition of the globe.

Besides, we find that PEVC investors might increase their capital invested to ESG bond issuers, but only to those with higher environmental expenditure. This finding contrasts with existing literature that investors react positively to the post-issuance environmental performance, our finding suggests that sophisticated investors actually consider whether ESG bond issuers have really made efforts in improving their environmental footprint. This also yield important policy implication that government authorities should promote more sustainable disclosure, especially regarding firms' efforts in promoting sustainable finance, so as to attract capitals in the private sector and foster a better green finance market development.

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