Do green bonds affect stock returns and corporate environmental performance? Evidence from China

Ruixin Fan[1], Xiong Xiong[1,2], Youwei Li[3], Ya Gao[4*]

1. College of Management and Economics, Tianjin University, Tianjin, 300072, China

2. Laboratory of Computation and Analytics of Complex Management Systems (CACMS)，Tianjin University，Tianjin, 300072, China

3. Hull University Business School, University of Hull, HU6 7RX, United Kingdom

4. School of Economics and Management, Dalian University of Technology, Dalian 116024, China

Abstract:

We reveal the positive short-term stock market reaction to the announcement of green bond issuance, which does not exist for factual green bonds. For long-term performance, green bond issuance promotes corporate environmental information disclosure and attracts green investors.

Keywords: Green bond issuance; Factual green bonds; Market reaction; Environmental information disclosure; Green investors

JEL: G14; G32

E-mail address:

fanruixin0933@163.com (Ruixin Fan); xxpeter@tju.edu.cn (Xiong Xiong);
Youwei.Li@hull.ac.uk (Youwei Li); gaoya@dlut.edu.cn (Ya Gao)

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[1] ***Corresponding author**: Ya Gao. **Correspondence to**: School of Economics and Management, Dalian University of Technology, Dalian, 116024, China. E-mail: gaoya@dlut.edu.cn (Ya Gao). Telephone: 0086-15022434153

Highlights

- Finds the different market reactions to the announcement and issuance of green bonds.
- Analyzes the importance of green labels in the Chinese stock market by comparing the market reactions to labeled and unlabeled (factual) green bonds.
- Reveals the positive impact of green bond issuance on corporate environmental information exposure in the long term.

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1. Introduction

Growing concerns about climate change (Yan et al., 2022) have promoted the generation of eco-friendly investment tools (Friedman and Heinle, 2016; Xu et al., 2023), and among them, green bonds have become increasingly popular and are widely issued in many countries.

The pricing of green bonds is the key factor to support the development of this new green financial tool. Previous studies reveal ambiguous findings about the pricing between green and conventional bonds: some find that green bonds are issued at a premium (Pástor et al., 2022), while others provide the opposite evidence (Flammer, 2021). The spillover to the capital market also attracts academia's attention, and some studies find that green bond issuance has a positive influence on stock prices and gains trading preference from investors (Tang and Zhang, 2020; Flammer, 2021). Pricing efficiency relies on the trading conditions and information transparency, and among the universal financial markets, the Chinese financial market has some unique features: as the largest green bonds' home country (Flammer, 2021), there is a relatively loose green bond issuance standard (no less than 50% of the raised funds for corporate business activities, compared to 90% international standard). Besides, the spillover effect relies on the conveying of the green signal to attract investors, however, the trading is dominated by irrational and uninformed individual investors in the Chinese stock market. Therefore, it might be difficult for these investors to distinguish the company's green performance from the green label, and the short-term influence might differ from the mainstream findings.

The long-term performance of green bond issuance might also be different in China. Ideally, green bonds would benefit environmental protection by mitigating carbon market risk (Jin et al., 2020), reducing CO2 emissions (Xu and Li, 2023), the carbon intensity of their assets (Fatica and Panzica, 2021), the cost of capital (Zhang et al., 2021) and improving energy efficiency (Anh Tu and Rasoulinezhad, 2022). However, corporate environmental activities like issuing green bonds might be related to greenwashing behavior (Berrone et al., 2017), and the loose issuance standard and the immature investors make it necessary to empirically study whether green bonds fulfill their role in environmental protection.

Based on these concerns, we analyze the evolution of Chinese green bonds, define factual green bonds based on the China Bond website, explore the short- and long-term influence of

(factual) green bonds, and reveal the importance of green labels. First, we find that the green bonds issued by listed companies account for 12% (19.1%) of the total number (amount), and could link two financial markets. Second, consistent with Tang and Zhang (2020), we reveal that the stock market responds positively to the announcement of green bonds in the short term. More importantly, we discover that some bonds are with green activities (factual green bonds) but without green labels, and the stock market ignores them and only reacts to the green labels. Third, we find that green bond issuance promotes firms to improve their environmental information disclosure and attracts green investors in the long term.

This paper contributes twofold. First, we screen out factual green bonds from conventional bonds. Different from studies analyzing the influence of green labels on bond pricing (Karpf and Mandel, 2018), we distinguish the market reactions to labeled and unlabeled (factual) green bonds and reveal that it is green activities matter for the short-term market reaction. Second, for the influence of the long-term performance of green bonds, information transparency matters in distinguishing greenwashing and real green. Therefore, instead of using the green activity measures (Fatica and Panzica, 2021; Flammer, 2021), we choose the firms' environmental information disclosure as the main proxy to measure the long-term performance, considering it not only measures firm's green performance but also contributes to improving corporate transparency, attracting long-term green investors and benefit to the stable development of the green bond market in the long run.

2. Data

Our data includes 2160 green bonds issued by listed companies from 5 January 2016 to 28 February 2022[1]. Green bonds, firm-specific variables, and trading data are from the CSMAR and RESSET databases. We use the way in the China Bond website to define the factual green bonds--the bonds use no less than 50% of raised money to invest in one of the four green bond project classifications: *Catalogue of Projects Supported by Green Bonds (2015), Guidelines on the Issuance of Green Bonds, Green Bond Principles, and Climate Bonds Taxonomy*.

In Online Appendix Table A.1- A.5, we report the development of green bonds in different years, industries, regions, and companies, and compare the features of listed companies that

[1] The Chinese green bond market is policy-oriented, and in 2015 and 2016, the government released a series of green bond policies. Following these policies, companies began to issue green bonds and the market started in 2016.

have or have not issued green bonds.

3. Short-term stock market reaction

3.1 Event study

We use the event study method to explore the influence of green bond issuance based on the announcement and issuance date (day 0). The abnormal return (AR) and cumulative abnormal return (CAR) are calculated through the following market-adjusted model:

$$AR_{i,t} = R_{i,t} - R_{mt} \quad (1)$$

where $R_{i,t}$ is the return for stock i on day t and R_{mt} is the daily market return. The CAR from the event window $[t1,\ t2]$ is calculated as follows.

$$CAR_{t1,t2} = \sum_{t1}^{t2} AR_t \quad (2)$$

Table 1 reports the results of the event study. For 132 announcement events, the CAR on the event day [0] is 0.35, significant at the 5% level. This abnormal return lasts for the following five days, with values of 1.01 and 1.36 for windows [1,5] and [0, 5], and significant at the 1% level. Findings indicate that the stock market responds positively to the announcements, consistent with Tang and Zhang (2020). In comparison, the results based on issuance dates are insignificant, which could be because no new information is conveyed to the market and investors do not react, consistent with Flammer (2021). The robustness tests and heterogeneity analysis are shown in Online Appendix Tables A.6 and A.7, verifying the results.

3.2 Factual green bonds

Following the *Guidelines on the Issuance of Green Bonds*, Chinese green bonds need to meet the requirements of investing more than 50% raised money in green activities. Besides, issuers still need to disclose related information under supervision. Based on this situation, some firms might be "lazy" or lack the motivation to obtain this green identification (label), even when they issue factual green bonds. We match the factual green bond data with all bonds, and do identify some conventional bonds with factual green performance and contribute to the development of green projects, same as green bonds.

Therefore, there could be two types: labeled green bonds and those unlabeled factual green bonds. In **Table 2**, we study the different market reactions to them and use international green standards (95% raised money invested in green activities) for further study. For all bonds with the 50% standard, $CAR[0,5]$ is significant at the 5% level, mainly from the labeled subsample

(with a value of 1.36 and t-statistics of 3.28) and the unlabeled subsample is insignificant. The difference between the two subsamples is positive at the 5% level. The results based on the 95% standard draw a similar conclusion, indicating the importance of green identification. More information conveyed by green labels and the limited attention of investors (Ben-Rephael et al., 2017) might be the reason. In addition, the reaction to labeled green bonds with the higher standard is larger (with a value of 2.69 for the 95% standard and 1.36 for the 50% standard), suggesting that the stock market is concerned about factual green activities.

4. Long-term corporate performance

We explore the long-term impact of green bonds based on the regression models following Fatica and Panzica (2021):

$$Y_{i,t} = \alpha_i + \beta_{1i} Green_{i,t} + \beta_{2i} Control_{i,t-1} + \varepsilon_{i,t} \quad (3)$$

where $Y_{i,t}$ represents corporate environmental performance, including variables EM, EP, EG, and IO_Green. EM, EP, and EG are the number of environmental management, pollution, and governance information disclosed by enterprises, respectively, and IO_Green is the shareholding ratio of green investors. We set listed companies that have issued green bonds as the treatment group and use those never issued green bonds but in the same industries of the treatment group as the control group. $Green_{i,t}$ is a dummy variable that equals one (zero) if firm i is in the treatment (control) group in year t. $Controls_{i,t}$ are several firm-level characteristics, including $Size$, $Tobin's\ Q$, ROA, Age, PPE, $Independence$, and $Duality$. Detailed definitions are in Online Appendix B.

Table 3 reports the regression results. The influences of green bond issuance on EM, EP, EG, and IO_Green are all significantly positive at the 1% level, proving that the issuance of green bonds promotes firms to improve their environmental performance. The robustness tests in Online Appendix Table A.8 and Figure A.1 verify the results. The heterogeneity analysis is reported in Online Appendix Table A.9, showing a stronger influence for firms with relatively weaker current performance and indicating green investors support the green transformation of firms with worse environmental performance.

5. Conclusion

This paper provides evidence about the short- and long-term influence of green bond

issuance. First, we find a positive stock market reaction to the announcement of green bond issuance and reveal investors' ignorance of the unlabeled factual green bonds. Second, we find that green bond issuance promotes firms to improve their environmental information disclosure and attract green investors in the long term. Our study reveals the promotion effect of green bonds on environmental protection. The findings could guide companies issuing factual green bonds to get green labels to attract investors, considering it is tough for investors to distinguish the unlabeled factual green bonds.

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Reference

Anh Tu, C., & Rasoulinezhad, E. (2022). Energy efficiency financing and the role of green bond: policies for post-Covid period. China Finance Review International, 12(2), 203-218.

Ben-Rephael, A., Da, Z., & Israelsen, R. D. (2017). It depends on where you search: Institutional investor attention and underreaction to news. The Review of Financial Studies, 30(9), 3009-3047.

Berrone, P., Fosfuri, A., & Gelabert, L. (2017). Does greenwashing pay off? Understanding the relationship between environmental actions and environmental legitimacy. Journal of Business Ethics, 144, 363-379.

Fatica, S., & Panzica, R. (2021). Green bonds as a tool against climate change?. Business Strategy and the Environment, 30(5), 2688-2701.

Flammer, C. (2021). Corporate green bonds. Journal of Financial Economics, 142(2), 499-516.

Friedman, H. L., & Heinle, M. S. (2016). Taste, information, and asset prices: Implications for the valuation of CSR. Review of Accounting Studies, 21(3), 740-767.

Karpf, A., & Mandel, A. (2018). The changing value of the 'green' label on the US municipal bond market. Nature Climate Change, 8(2), 161-165.

Jin, J., Han, L., Wu, L., & Zeng, H. (2020). The hedging effect of green bonds on carbon market risk. International Review of Financial Analysis, 71, 101509.

Pástor, Ľ., Stambaugh, R. F., & Taylor, L. A. (2022). Dissecting green returns. Journal of Financial Economics, 146(2), 403-424.

Tang, D. Y., & Zhang, Y. (2020). Do shareholders benefit from green bonds?. Journal of Corporate Finance, 61, 101427.

Xu, X., & Li, J. (2023). Can green bonds reduce the carbon emissions of cities in China?. Economics Letters, 226, 111099.

Xu, A., Zhu, Y., & Wang, W. (2023). Micro green technology innovation effects of green finance pilot policy—From the perspectives of action points and green value. Journal of Business Research, 159, 113724.

Yan, Y., Xiong, X., Li, S., & Lu, L. (2022). Will temperature change reduce stock returns? Evidence from China. International Review of Financial Analysis, 81, 102112.

Zhang, R., Li, Y., & Liu, Y. (2021). Green bond issuance and corporate cost of capital. Pacific-Basin Finance Journal, 69, 101626.

Tables

Table 1 Stock market reaction to the issuance of green bonds

The results are in percentage values, and N is the number of samples. Significance at the 1%, 5%, and 10% levels are denoted as ***, **, and *, respectively.

Panel A: Announcement Date				Panel B: Issuance Date			
Event time	CAR	T-statistics	N	Event time	CAR	T-statistics	N
[-10, -6]	0.42	1.02	132	[-10, -6]	0.41	1.10	146
[-5, -1]	-0.27	-0.60		[-5, -1]	0.19	0.44	
[0]	0.35**	2.10		[0]	0.21	1.10	
[1, 5]	1.01***	2.68		[1, 5]	0.34	0.95	
[0, 5]	1.36***	3.28		[0, 5]	0.55	1.35	
[6, 10]	-0.27	-0.67		[6, 10]	-0.56	-1.43	
[11, 20]	-0.80	-1.60		[11, 20]	-0.09	-0.19	
[21, 40]	-0.78	-1.18		[21, 40]	-0.93*	-1.67	

Table 2 Stock market reaction to labeled and unlabeled green bonds

The results are in percentage values, values in parentheses are t-statistics, and N is the number of subsamples. Significance at the 1%, 5%, and 10% levels is denoted as ***, **, and *, respectively.

50% standard	All	Labeled	Unlabeled	Diff (Labeled minus Unlabeled)
$CAR[0,5]$	0.78**	1.36***	-0.14	1.50**
	(2.47)	(3.28)	(-0.29)	(2.36)
N	215	132	83	
95% standard	All	Labeled	Unlabeled	Diff (Labeled minus Unlabeled)
$CAR[0,5]$	0.87	2.69**	-0.56	3.25**
	(1.33)	(2.30)	(-0.88)	(2.44)
N	68	30	38	

Table 3 Green bond issuance and long-term corporate performance

Values in parentheses are t-statistics. Significance at the 1%, 5%, and 10% levels is denoted as ***, **, and *, respectively.

Dep. Var.	EM (1)	EP (2)	EG (3)	IO_Green (4)
$Green$	0.82***	0.47***	0.61***	0.02***
	(3.70)	(2.88)	(2.74)	(2.78)
$Size$	0.76***	0.48***	0.56***	0.02***
	(23.97)	(20.61)	(17.64)	(14.36)
$Tobin's\ Q$	-0.60***	-0.38***	-0.39***	0.01**
	(-10.05)	(-8.72)	(-6.57)	(2.29)
ROA	0.76	-0.26	0.86	0.06
	(0.66)	(-0.31)	(0.74)	(1.45)
$Duality$	-0.18*	-0.10	-0.03	0.01*
	(-1.85)	(-1.42)	(-0.29)	(1.76)
$Independence$	0.10	0.41	0.18	-0.03*
	(0.20)	(1.16)	(0.37)	(-1.85)
Age	0.01**	0.01	0.02***	-0.001
	(1.97)	(1.05)	(2.93)	(-0.85)
PPE	1.29***	1.79***	2.39***	-0.001
	(4.98)	(9.37)	(9.14)	(-0.22)
Cons	-13.81***	-8.78***	-10.34***	-0.37***
	(-17.87)	(-15.42)	(-13.24)	(-13.38)
Industry fixed effects	Y	Y	Y	Y
Observations	2,478	2,478	2,478	2,955
R^2	0.29	0.30	0.26	0.09

Appendices

Online Appendix A

Table A.1 Summary statistics of green bonds

This table provides the number and amount of green bonds issued by government agencies (including the financial department and policy banks) and companies. Besides, we also report the summary statistics of a special composition of all companies—the listed companies for comparison. The sample period is from 5 January 2016 to 28 February 2022. The unit of the amount is billion.

	Total		Government		Companies		Listed companies	
Year	Number	Amount	Number	Amount	Number	Amount	Number	Amount
2016	97	358.30	3	14	94	344.3	15	134.98
2017	198	290.04	5	32	193	258.04	26	64.16
2018	218	304.42	-	-	218	304.42	19	78.29
2019	423	399.78	13	26.35	410	373.43	58	65.05
2020	357	324.09	9	33.78	348	290.31	31	29.90
2021	764	725.50	17	75.28	747	650.22	95	75.58
2022	103	186.89	2	15	101	171.89	16	46.38
Total	2160	2589.02	49	196.41	2111	2392.61	260	494.34

Table A.2 Characteristics of green bonds in different industries

This table provides the number and amount of green bonds issued by listed companies and the sum of number (Sum_N) and amount (Sum_A) from 8 industries. The classification follows the guidelines for the industry classification of listed companies in China in 2012. The unit of the amount is billion.

Industry	Classification	Number	Amount	Sum_N	Sum_A
Finance	Capital market services	98	27.78	134	385.78
	Monetary and financial services	36	358.00		
Basic products supply	Electricity, heat production and supply	47	50.26	63	61.64
	Water production and supply	12	9.29		
	Gas production and supply industry	4	2.19		
Manufacturing	Smelting and pressing of ferrous metals	5	5.40	39	26.38
	Manufacture of metal products	5	4.25		
	Non-metallic mineral products industry	5	2.25		
	Manufacture of electrical machinery and equipment	5	1.50		
	Chemical fiber manufacturing	4	4.00		
	Automobile industry	4	4.00		
	Comprehensive utilization of waste resources	3	1.60		
	Manufacture of general machinery	3	1.57		
	Smelting and pressing of non-ferrous metals	3	1.42		
	Chemical raw materials and chemical products manufacturing	1	0.30		
	Paper and paper products industry	1	0.09		
Public facility	Ecological protection and environmental management industry	13	8.08	13	8.08
Mining	Non-ferrous metals mining and dressing	3	1.45	5	4.97
	Oil and gas extraction industry	1	2.55		
	Mining and washing of coal industry	1	0.97		
Construction	Civil engineering construction industry	3	5.20	3	5.20
Wholesale	Wholesale industry	2	1.20	2	1.20
Real estate	Real estate	1	1.09	1	1.09
Total		260	494.34	260	494.34

Table A.3 Number of green bonds in each province

This table provides the number and amount of green bonds issued by listed companies from different provinces (including 22 regions in China). The unit of the amount is billion.

Province	Number	Amount	Province	Number	Amount
Guangdong	47	33.37	Sichuan	6	5.00
Beijing	43	115.95	Liaoning	5	3.44
Jiangsu	43	32.25	Henan	3	3.12
Hubei	29	9.05	Anhui	3	1.09
Shanghai	14	104.59	Guizhou	2	8.00
Fujian	10	130.75	Xinjiang	2	1.50
Zhejiang	9	8.12	Gansu	2	1.00
Hebei	9	7.44	Hunan	1	5.00
Yunnan	9	5.92	Neimeng	1	0.51
Guangxi	9	1.83	Shanxi	1	0.15
Chongqing	6	8.50			
Shandong	6	7.75	Total	260	494.34

Table A.4 Summary statistics of green bonds issued by different companies

This table provides summary statistics for green bonds issued by different companies, including those from state-owned enterprises, Sino-foreign joint ventures, private firms, and other listed companies. The summary statistics include the number of green bonds, the number of issuers, the average issued amount, a dummy variable for the independent third-party certifications (Certified), the bond period, a dummy variable for the fixed-rate bonds (Fixed-rate bond), the coupons for the fixed-rate bonds, and the credit rating of green bonds and their issuers (Corporate rating). The unit of the average amount is a billion, and the bond period is a year. The data of third-party certification is from the website of China Financial Information.

	All	State-owned	Sino-foreign	Private	Other
No. green bonds	260	198	17	36	9
No. green bond issuer	90	59	7	21	3
Average issued amount	19.01	21.00	7.24	6.88	46.11
Certified	0.17	0.13	0.24	0.25	0.78
Bond period	4.12	4.15	4.21	4.06	3.57
Fixed-rate bond	0.94	0.93	0.82	1.00	1.00
Coupon (%)	4.21	4.00	3.91	5.43	4.22
Bond rating	AAA	AAA	AAA	AA+	AAA
Corporate rating	AAA	AAA	AAA	AA	AAA

Table A.5 Comparison between green and nongreen bond issuers

This table provides summary statistics of the company characteristics of green bond issuers and nongreen bond issuers. Descriptions include the mean value, standard deviation, and the differences and the associated t-statistics values between two issuers. Company characteristics variables include the logarithm value of market capitalization ($Size$), return on assets (ROA), the ratio of the market value to total assets ($Tobin's\ Q$), financial leverage (Lev), ESG score (ESG), environment score (E), social score (S), and governance score (G). Significance at the 1%, 5%, and 10% levels are denoted as ***, **, and *, respectively. The ESG data is from the Bloomberg database.

	Green bond issuers		Nongreen bond issuers		Nongreen minus Green	T-statistics
	Mean	Std	Mean	Std		
$Size$	23.97	0.17	23.42	0.15	0.55***	4.58
ROA	0.032	0.003	0.02	0.004	0.01**	2.33
$Tobin's\ Q$	1.33	0.10	1.23	0.06	0.08	1.10
Lev	0.66	0.02	0.63	0.02	0.03	1.64
ESG	29.28	1.44	25.82	0.64	3.46***	3.30
E	17.32	2.06	15.16	0.87	2.15	1.46
S	34.45	1.93	28.45	0.64	6.00***	3.10
G	50.66	1.09	49.19	0.45	1.47*	1.76

Table A.6 Robustness tests of the event study

This table provides cumulative abnormal returns (CAR) calculated by several different ways of event study based on the announcement date. Specifically, we employ a composite market return and market model to calculate CAR, and we also report the results based on the samples excluding financial companies and only choosing the first announcement in each month. The CAR includes three intervals: [0], [1, 5], and [0, 5], and values in parentheses are t-statistics. N is the number of samples. Significance at the 1%, 5%, and 10% levels is denoted as ***, **, and *, respectively.

CAR	Composite market return	Market model	Excluding financial companies	Choosing only first announcement in each month
[0]	0.37**	0.32**	0.42**	0.38**
	(2.33)	(1.99)	(2.09)	(2.21)
[1,5]	1.01***	0.77**	1.18**	1.01**
	(2.66)	(2.14)	(2.55)	(2.57)
[0,5]	1.38***	1.09***	1.60***	1.39***
	(3.30)	(2.74)	(3.15)	(3.23)
N	132	132	105	126

Table A.7 Heterogeneity analysis of the event study

This table provides cumulative abnormal returns $CAR[0,5]$ for different subsamples. Specifically, we distinguish green bond issuers as state-owned and non-state-owned, first-time and seasoned issuance, issuing green bonds only once and more than once, issuing green bonds with and without independent third parties' certification. This table also reports the differences between the two subsamples. Values in parentheses are t-statistics, and N is the number of events. The sample period is from 5 January 2016 to 28 February 2022, except for the data of independent third parties' certifications (ends December 2019). Significance at the 1%, 5%, and 10% levels is denoted as ***, **, and *, respectively.

	State-owned enterprises		First-time issuance		Issuing green bond once		With Certification	
CAR	Yes	No	Yes	No	Yes	No	Yes	No
[0,5]	1.92***	0.11	1.44**	1.26**	2.10**	1.04**	0.97*	-1.02
	(3.86)	(0.15)	(2.27)	(2.55)	(2.11)	(2.55)	(1.83)	(-1.55)
N	91	41	74	58	40	92	36	26
Diff	1.81**		0.18		1.06		1.99**	
(Yes-No)	(2.04)		(0.22)		(0.99)		(2.36)	

Table A.8 Robustness tests for regression

This table reports robustness tests of the influences of green bond issuance on corporate performance. In panel A, we use the nearest neighbor matching based on seven characteristics ($Size$, $Tobin's\ Q$, ROA, Age, Ppe, $Independence$, and $Duality$ in $t-1$) to match firms in the treatment and control groups. In panel B, we add several additional control variables in the regression model including the financial leverage (Lev), the number of board directors ($Boardsize$), book to market ratio (BM), and institutional ownership (IO). In panel C, we add more fixed effects into our regression including the year fixed, province fixed, and the cross term of year and industry. In panel D, we use a logit regression model based on the dummy dependent variables and we define $Dummy\_EM$ as equal to one if the enterprise environmental management information disclosure indicator (EM) for firm i in year t is not empty and equals zero otherwise, and other dummy independent variables are defined similarly. We control the industry-fixed effects for the regressions, and values in parentheses are t-statistics. Significance at the 1%, 5%, and 10% levels is denoted as ***, **, and *, respectively.

Dep. Var.	EM	EP	EG	IO_Green
Panel A: Propensity score matching				
$Green$	0.82***	0.46***	0.61***	0.02***
	(3.67)	(2.82)	(2.70)	(2.91)
Control variables	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y
Observations	2,450	2,450	2,450	2,925
R^2	0.29	0.31	0.26	0.09
Panel B: Adding additional control variables				
$Green$	0.81***	0.45***	0.58***	0.02***
	(3.67)	(2.81)	(2.60)	(2.59)
Lev	0.20	-0.09	0.08	0.03***
	(0.65)	(-0.42)	(0.26)	(2.99)
$Boardsize$	0.23	0.03	-0.10	-0.01
	(1.51)	(0.24)	(-0.64)	(-0.82)
BM	2.16***	1.65***	1.61***	-0.02
	(6.52)	(6.78)	(4.77)	(-1.35)
IO	0.51***	0.13	0.22	-0.01**
	(2.88)	(1.04)	(1.20)	(-2.01)
Control variables	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y
Observations	2,450	2,450	2,450	2,915
R^2	0.30	0.32	0.26	0.09
Panel C: Adding more fixed effects regressions				
$Green$	0.61**	0.43**	0.57**	0.02*
	(2.48)	(2.36)	(2.23)	(1.76)
Control variables	Y	Y	Y	Y
Industry fixed	Y	Y	Y	Y
Year fixed	Y	Y	Y	Y
Province	Y	Y	Y	Y
Year × Industry	Y	Y	Y	Y
Observations	2,478	2,478	2,478	2,955

R^2	0.36	0.34	0.32	0.12
Panel D: Dummy dependent variables				
Dep. Var.	$Dummy\_EM$	$Dummy\_EP$	$Dummy\_EG$	$Dummy\_IO$
$Green$	1.05**	0.80**	0.68**	0.85***
	(2.12)	(2.47)	(2.03)	(3.36)
Control variables	Y	Y	Y	Y
Industry fixed effects	Y	Y	Y	Y
Observations	2,478	2,478	2,478	2,955
R^2	0.17	0.16	0.14	0.23

Table A.9 Heterogeneity analysis based on environmental performance

This table reports the results of the heterogeneity analysis. Specifically, we separate the whole sample into three kinds of subsamples. The first one is the high- and low-polluting subsamples according to the *environmental protection verification industry classification management directory of listed companies*; the second kind is based on the environmental performance scores, and we classify firms with scores above (below) the median value as the better (worse) environmental performance subsamples; for the third kind of subsample, we classify firms into the state-owned and non-state-owned companies. Panels A, B, C report the results of three independent variables EP, EG, and EM, and in Panel D, we perform subsample studies based on IO_Green. Values in parentheses are t-statistics. Significance at the 1%, 5%, and 10% levels is denoted as ***, **, and *, respectively.

Panel A	High pollution enterprises			Low pollution enterprises		
	EM	EP	EG	EM	EP	EG
$Green$	0.63*	0.08	0.52	0.88***	0.74***	0.63**
	(1.77)	(0.31)	(1.44)	(3.29)	(4.35)	(2.42)
Control	Y	Y	Y	Y	Y	Y
Industry fixed	Y	Y	Y	Y	Y	Y
Observations	1,528	1,528	1,528	950	950	950
R^2	0.31	0.30	0.23	0.23	0.20	0.20
Panel B	Better environmental performance			Worse environmental performance		
	EM	EP	EG	EM	EP	EG
$Green$	0.38	0.13	0.21	0.74*	0.67**	0.60
	(1.01)	(0.43)	(0.61)	(1.83)	(2.36)	(1.37)
Control	Y	Y	Y	Y	Y	Y
Industry fixed	Y	Y	Y	Y	Y	Y
Observations	711	711	711	738	738	738
R^2	0.20	0.26	0.25	0.09	0.25	0.18
Panel C	State-owned enterprises			Non-state-owned enterprises		
	EM	EP	EG	EM	EP	EG
$Green$	0.86***	0.34	0.37	0.70**	0.66***	0.91***
	(2.90)	(1.54)	(1.26)	(2.14)	(2.75)	(2.64)
Control	Y	Y	Y	Y	Y	Y
Industry fixed	Y	Y	Y	Y	Y	Y
Observations	1,416	1,416	1,416	1,062	1,062	1,062
R^2	0.30	0.32	0.28	0.27	0.27	0.23

Panel D	High- and low- polluting		Environmental performance		State-owned or non-state-owned	
Dep. Var.: IO_Green	High	Low	Better	Worse	State-owned	non-state-owned
$Green$	0.02***	0.02	0.01	0.02***	0.01	0.04**
	(3.68)	(1.47)	(0.72)	(2.99)	(1.38)	(2.46)
Control	Y	Y	Y	Y	Y	Y
Industry fixed	Y	Y	Y	Y	Y	Y
Observations	1,810	1,145	825	874	1,744	1,211
R^2	0.12	0.10	0.10	0.10	0.19	0.09

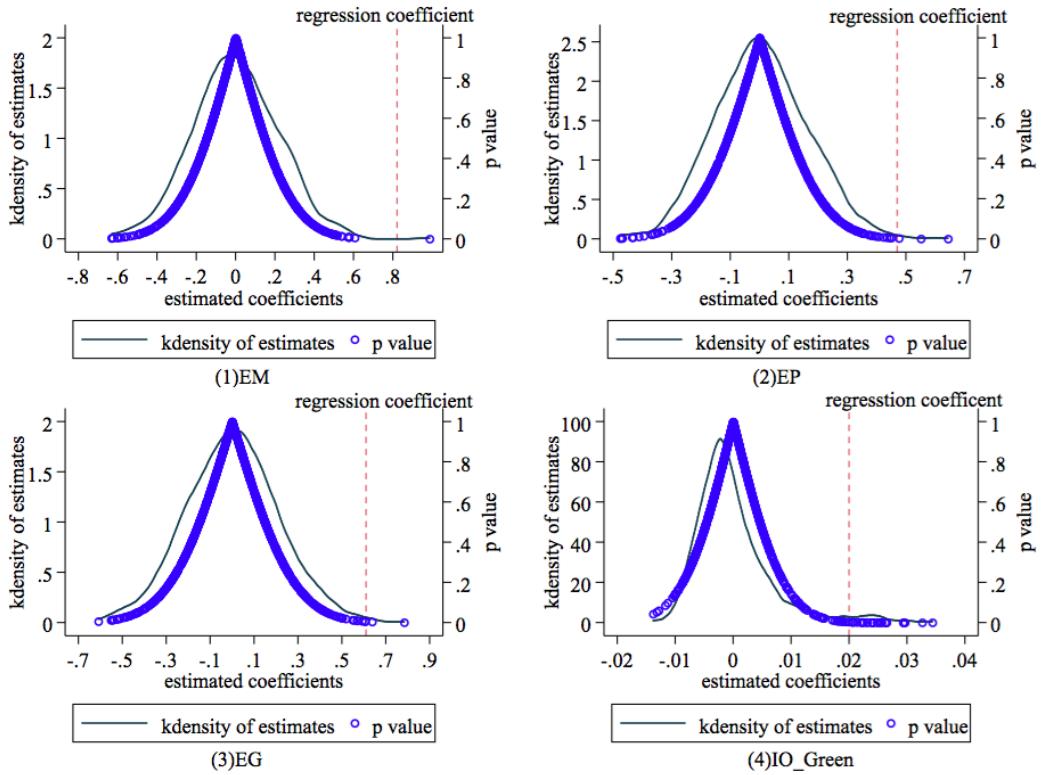

Figure A.1 Placebo Test

This figure shows the kernel density distribution and p values of placebo tests by randomly selecting firms that do not issue green bonds as the treatment group and repeating the regressions of Eq. (6) to obtain the impact of pretended green bond issuance on corporate environmental performance. Figures (1), (2), (3), and (4) report the kernel density distribution and p values by using the number of environmental management information (EM), the number of environmental pollution information (EP), the number of environmental governance information (EG), and the shareholding ratio of green investors (IO_Green) as the dependent variables, respectively. We also show the baseline regression results from Table 3 in this figure.

Online Appendix B. Variable Definition

Notation	Definition (Definitions are for the year t unless specified)
EM_t	The number of environmental management information disclosed by enterprises, involving 8 aspects (environmental protection concepts, environmental protection objectives, environmental protection management system environmental protection education and training, environmental protection special actions, environmental emergency mechanism, environmental protection honors or awards, and "three simultaneous" system)
EP_t	The number of environmental pollution information disclosed by enterprises, involving 6 aspects (including wastewater discharge, SO2 discharge, CO2 discharge, COD discharge, soot and dust discharge, and industrial solid waste production).
EG_t	The number of environmental governance information disclosed by enterprises, involving 7 aspects (whether it is a key pollution monitoring unit, whether pollutant emission is up to standard, whether there are environmental accidents, whether there are environmental illegal events, environmental petition cases, whether it has passed ISO14001 certification and whether it has passed ISO9001 certification).
IO_Green_t	The shareholding ratio of green investors. Green investors are funds whose investment objectives and investment scope involve the keywords environmental protection, ecology, new sources, low-carbon, clean, renewable energy, responsible investment, ESG, and energy conservation.
$Green_t$	A dummy variable that equals one if firm i issue green bonds in year t and equals zero if firm i issue conventional bonds in year t.
$Size_t$	The logarithm value of market capitalization.
$Tobin's\ Q_t$	The ratio of the market value of total assets (obtained as the book value of total assets plus the market value of common stock minus the book value of common stock) to the book value of total assets.
ROA_t	Net profit divided by the total assets.
Lev_t	Total debts divided by the total assets.
ESG_t	ESG score from the Bloomberg database, including environment score, social score, and governance score.
$Duality_t$	A dummy variable that equals 1 if the CEO and chairman are the same person in fiscal year t and 0 otherwise.
$Independence_t$	The proportion of independent directors on the board.
Age_t	The number of years since the firm's first appearance on the CSMAR database.
PPE_t	The ratio of fixed assets to total assets.
$Boardsize_t$	The logarithm value of the number of board directors in the board.
BM_t	The firm's book-to-market ratio.
Lev_t	Total debts divided by the total assets.
IO_t	Institutional ownership, defined as the proportion of stocks owned by institutions.