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The Impact of Green Bonds on Corporate ESG Ratings

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Abstract. This study aims to deeply analyze the mechanism by which the issuance of green bonds affects the ESG evaluation of enterprises. Using the sample of Chinese A-share listed companies from 2014 to 2023, the dual difference method was employed to empirically analyze the impact of green bond issuance on the ESG performance of companies and its mechanism. The study found: Firstly, compared with enterprises that issue ordinary bonds, the issuance of green bonds significantly improved the ESG rating of enterprises. This conclusion remained robust even after controlling for endogeneity issues and replacing variables. Secondly, the mechanism test indicated that green bonds indirectly improved the ESG performance of enterprises through three paths: enhancing information disclosure transparency, reducing agency costs, and promoting green innovation. Thirdly, the heterogeneity analysis showed that the promotion effect of green bonds on ESG was more significant in non-state-owned enterprises, heavy-polluting industries, and enterprises in the eastern region. This study not only enriches the theoretical system of green finance and enterprise sustainable development, but also provides empirical evidence for policy makers to guide enterprises to optimize ESG practices through green bond financing.

Keywords: green bonds, ESG, Corporate Sustainable Development

1. Introduction

ESG stands for Environmental, Social, and Governance. It looks at a company's sustainability and future potential. It goes further than regular corporate social responsibility. In recent years, ESG has become more important in business and investment decisions. China started ESG efforts later than many other countries. But it has grown quickly. This growth happened as green finance expanded. Green finance and ESG now work well together. They help companies develop in a high-quality and sustainable way. Investors now often include ESG factors in their analysis. Companies also use ESG ideas in their governance. This pushes firms to do better on ESG. At the same time, China's green finance market has grown a lot. China has issued the most green bonds in the world for two years in a row. It is also connecting more closely with global financial markets [1].

China's bond market has developed for thirty years. It now has a multi-tiered structure. This structure works under a system of "unified rules and classified supervision." Different government departments have worked together. This cooperation has helped create new types of bonds [2]. China's bond market has developed for thirty years. It now has a multi-tiered structure. This structure works under a system of "unified rules and classified supervision." Different government

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departments have worked together. This cooperation has helped create new types of bonds [3]. The ESG performance framework uses evaluation metrics, better disclosure, and market incentives. It provides clear benchmarks. It also offers feedback mechanisms. This framework turns ESG practices from voluntary actions into required rules.

Green bonds raise money for environmental protection. They also fund renewable energy, climate mitigation, and resource conservation. These bonds give financial support to green projects. They help the economy shift toward low-carbon activities. This increases demand for ESG-oriented investment.

Green bonds and corporate sustainability have been studied actively. Researchers have produced useful findings. However, few studies look closely at how green bonds affect corporate ESG indicators. This paper tries to improve understanding of how companies pursue sustainable development. It also explores how green finance works. The paper offers a new way to study how issuing green bonds affects corporate ESG scores. It supports future research on ESG changes in different industries and company sizes after green bond issuance. The paper also suggests specific policy ideas for governments, financial regulators, and businesses.

The innovations of this study are mainly reflected in the following aspects:

This study looks at how green bonds affect companies by using a full ESG view. It avoids the limits of simple, one-sided analysis. It shows how green financing helps improve corporate sustainability in multiple ways. The study first checks how information disclosure, agency costs, and green innovation help explain this effect. These factors act as clear links between green bonds and better ESG results. The positive effect is stronger in state-owned companies, in heavily polluting industries, and in eastern regions. This shows that policies should be tailored to different groups instead of using the same rule for everyone. The study also deals with possible bias by using methods to handle endogeneity. It runs robustness tests to make sure the results are reliable. This gives other researchers a solid base to build on.

2. Literature review

Green bonds appeared first in international markets. The global green bond market began in 2007. That year, the European Investment Bank issued the "Climate Awareness Bond." This was the first green bond ever. In 2008, the World Bank issued its first green bond. After that, the market grew quickly. At first, only multilateral development banks issued green bonds. Now, governments, commercial banks, and corporations also issue them. In recent years, people around the world have paid more attention to sustainable development. Because of this, ESG principles have become important in company strategies and investment decisions. China's green finance market is still growing. Green bonds are helping support a low-carbon transition. They are also driving strong demand for ESG investing.

Academic research on green bonds and corporate sustainable development is growing around the world. Many studies now exist on this topic. Wang's research shows that issuing green bonds helps companies with green innovation. This effect becomes stronger when ownership is more concentrated. The effect becomes weaker when companies face serious financial constraints [4]. In a similar vein, Li et al. discover that issuing green bonds boosts the number of green innovations but has no effect on their quality [5].

Using monthly green bond data, Agliardi observed a significant negative premium of 11 basis points [6]. Green bond spreads are often smaller in nations with better ESG performance, and low spreads are linked as well with good environmental performance. Compared to traditional bonds, corporate green bonds, which are used to fund environmental projects, often entail less risk.

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However, the higher costs of government-issued green bonds may reflect funding for politically favored projects with uncertain benefits.

Regarding stock price and environmental effects, Chen Danning found that green bond issuance attracts investor attention and significantly boosts stock prices for listed companies, with a clear link between information disclosure and market performance [7]. Zhang Ping further demonstrated that the scale of green bond issuance, along with corporate financial metrics such as return on assets and profit margins, positively influences local government environmental governance [8].

Among existing studies, the vast majority suggest that green bond issuance significantly promotes corporate ESG performance. Research indicates that green bonds have a connection to better environmental and ESG disclosure, though not necessarily with reduced carbon emissions intensity. Ge Chunrui et al. found that green bonds boost ESG levels, especially in highly marketized regions, polluting industries, and well-managed firms. Ren Xiaoshu highlighted that green bonds improve ESG performance by easing financing constraints and reducing agency costs, with stronger effects in state-owned firms, non-heavy polluters, and after the "dual carbon" goals were introduced.

Current research looks at how green bonds affect ESG performance. It mainly focuses on financing and cost mechanisms. Chen et al. say that green bonds improve ESG performance. They do this by making information disclosure better. They also lower debt financing costs [9]. Tang et al. say that green bonds help fund environmental and social projects. They do this through financing mechanisms. Green bonds also show that companies are serious about going green. This can lead to better ESG performance. This effect is stronger when policy uncertainty is high [10]. Han et al. note that green bonds ease financing constraints. They also lower financing costs. They help optimize debt structures. These effects support corporate governance. They support environmental management. They support profitability. They support growth. They support green innovation. They support responsibility [11]. Ge Chunrui and Han Jun further highlight that green bonds improve ESG by stimulating green innovation and strengthening external oversight [12].

Existing studies show that research on the current mechanism is still not enough. There is little systematic and in-depth work on how green bonds affect corporate ESG evaluation at the micro level. The theoretical framework needs more development.

3. Theoretical analysis and research hypotheses

Stakeholder theory says companies should think about more than just shareholders. They should also think about creditors, employees, customers, suppliers, and governments. These groups affect the company's survival and growth. Issuing green bonds can improve ESG performance. It can also attract investors who care about sustainability. This may lead to better financing terms and lower borrowing costs. Better ESG performance then strengthens the company's brand. It also boosts competitiveness.

Principal–agent theory looks at situations where one person hires another. The principal does not have full information. The principal usually wants to increase wealth. The agent may care more about personal benefit. This difference can cause conflict. When a company issues green bonds, outside groups pay closer attention. These groups include investors, analysts, and the media. Their attention limits managers' self-serving actions. It also reduces greenwashing and other harmful behaviors [13].

Financing constraint theory says that problems in capital markets make external financing more expensive than internal funds. These problems include information asymmetry, agency costs, and transaction costs. Because of this, companies face financing constraints. Green bonds help reduce these problems. They require strong disclosure rules. This lowers information asymmetry. It also

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brings in investors who focus on green projects. Government policies that support green bonds help cut agency costs with creditors. Research shows that companies that issue green bonds have fewer financing constraints than those that do not. This is true when measured by the SA index. Bigger green bond issues ease these constraints even more [14].

3.1. Core hypothesis: the direct promoting effect of green bonds on corporate ESG performance

Green bond issuance helps companies get long-term, low-cost funding. This funding supports green innovation projects. These projects often take a long time to complete and carry high risks. With this support, companies can develop and use green technologies. This improves their environmental and social performance. Green innovation also pushes companies to improve their internal R&D management. This leads to sustainable, innovation-driven growth. It also raises overall ESG performance.

Green bonds require strict environmental information disclosure. Companies must report how they use the money. They also need to share project progress and environmental benefits. The disclosure follows standard rules. Third-party institutions usually check the information. This process makes company operations more transparent. It lowers the risk of greenwashing. It also brings in outside oversight. Outside oversight supports better corporate governance.

Based on this analysis, Hypothesis H1 is proposed: Green bond issuance can enhance corporate ESG performance.

3.2. Mechanism hypothesis: the transmission path of green bonds affecting corporate ESG performance

Green bond issuance places much stricter rules on companies than regular bonds. These rules cover how companies report their environmental and business information. Companies must improve how they disclose information. This helps them perform better on ESG measures. After issuing green bonds, companies face checks from government regulators. They also face close review from investors who care about values. The media and the public watch them more closely too. These outside checks lower the gap in information between companies and their stakeholders. Companies must then improve their internal systems for managing information. They also need to make their operations and governance more transparent.

Green bond issuance brings in different kinds of outside oversight. This helps reduce principal–agent problems. It also strengthens corporate governance. Green bond investors are usually long-term institutional investors, such as pension funds and insurance companies. These investors care about sustainable development. They watch closely how companies use the money they raise. The regulatory framework pushes companies to improve their internal governance processes. It helps cut losses caused by conflicts between managers and owners. It also leads companies to include environmental and social factors in their decisions.

Traditional financing channels often cannot meet the funding needs of sustainable projects. These channels have low risk tolerance. They also suffer from maturity mismatches. Green bonds give long-term, low-cost, and stable financing. Favorable policies and a "green premium" support them. This support eases funding constraints for green innovation. It also helps build an innovation-driven model for sustainable development.

Based on the above analysis, Hypothesis H2 is proposed: Corporate green bond issuance influences ESG ratings through three channels—improved information disclosure, reduced agency

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costs, and enhanced green innovation capacity.

3.3. Heterogeneity hypothesis: the contextual differences in the effectiveness of green bonds

The effect of green bond issuance on a firm's ESG performance is not the same for all firms. It depends on several factors. These include ownership structure, industry type, and regional setting.

State-owned enterprises often have stable financing sources. They also carry strong policy-driven social duties. Because of this, they face stricter external oversight when they issue green bonds. They must meet higher disclosure standards. Their green projects usually get more government support. This support can lead to clearer improvements in ESG performance.

Heavily polluting firms face strict environmental rules. They can use money from green bonds to upgrade pollution control systems. They can also switch to cleaner energy. This directly improves their environmental performance. These firms also get more attention from the public and media. That increases pressure to disclose information. It also raises the risk of greenwashing. As a result, they must improve their ESG management systems. For non-heavily polluting firms, green bonds may help more with governance and transparency.

Regional factors also affect how well green bonds work. These factors include the level of marketization, how strict environmental rules are, and how developed green finance is. In highly marketized regions, capital markets are more mature. These regions have more specialized green investors. They also have stronger oversight systems. Their green finance infrastructure is better too. Regions with stricter environmental rules give firms a stronger reason to improve the environment using green financing. In regions with low marketization and weak regulation, there is less outside pressure for ESG investment. In these places, green bonds may have less impact.

Accordingly, Hypothesis H3 is proposed: The effect of green bond issuance on corporate ESG performance is heterogeneous, being more significant for state-owned enterprises, heavily polluting firms, and enterprises located in regions with higher marketization and stricter environmental supervision.

4. Empirical analysis

4.1. Models and variables

The study object chosen for this article is sample data from China's A-share listed firms between 2014 and 2023. Among them, special treatment enterprises such as ST and *ST were excluded, and the sample of listed companies in the financial industry was also excluded. For continuous variables with relatively obvious extreme values, this paper also underpens them by 1% at the top and bottom. A total of 27,470 enterprise-year observations were obtained, involving 4,511 listed companies.

The variable discussed in this article is the ESG rating of enterprises. According to the rating of the ESG performance of each enterprise in the Huazheng database, the final score ranges from 1 to 9 points. However, since there is no 9-point situation in the actual situation, the highest score is only 8 [15].

The explanatory variable is the issuance of green bonds by companies. In this paper, the earliest year of the enterprise's issuance of green bonds is used as the basis for assignment. If the enterprise has issued green bonds before, it is the experimental group; otherwise, it is the control group. After the year when an enterprise issues green bonds, it indicates that it is in the post-event period, and at this time, the DID is assigned a value of 1.

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Mediating variables include information disclosure, agency costs and green innovation. Among them, the information disclosure indicators are represented by the assessment results of the enterprise's information disclosure in the current year, where 1 indicates unqualified, 2 indicates qualified, 3 indicates good, and 4 indicates excellent. The agency cost indicator is expressed by the asset turnover rate. The higher the value of this variable, the smaller the agency cost. The level of green innovation is expressed as the natural logarithm of the number of patent applications made by an enterprise in the current year.

Control variables include enterprise scale, equity concentration, asset-liability ratio, enterprise growth indicators, board size, and the proportion of independent directors. Among them, enterprise scale is expressed by the natural logarithm of total assets at the end of the year of the enterprise, equity concentration is expressed by the proportion of shares held by the largest shareholder, and the asset-liability ratio is expressed by the ratio of total liabilities to total assets. The growth indicators of enterprises are expressed by the growth rate of operating income, the size of the board of directors is expressed by the natural logarithm of the number of board members, and the proportion of independent directors is expressed by the ratio of the number of independent directors to the number of board members [16].

Regarding the impact of green bond issuance on the ESG performance of enterprises, this paper constructs a regression equation as shown in Formula (1) :

$$ESG_{it} = \alpha_0 + \beta_1 DID_{it} + \beta_2 CV_{it} + Industry_j + Year_t + \varepsilon_{it} \quad (1)$$

Among them, it represents the ESG performance of enterprise i in year t, which is a different-in-differences term, a set of control variables, including enterprise size, equity concentration, asset-liability ratio, enterprise growth indicators, board size, and the proportion of independent directors, and are respectively the industry fixed effect and the year fixed effect, which is the residual term.

Regarding the mediating effect test, this paper constructs the regression equations as shown in formulas (2) and (3).

$$M_{it} = \alpha_0 + \beta_1 DID_{it} + \beta_2 CV_{it} + Industry_j + Year_t + \varepsilon_{it} \quad (2)$$

$$ESG_{it} = \alpha_0 + \beta_1 DID_{it} + \beta_2 M_{it} + \beta_3 CV_{it} + Industry_j + Year_t + \varepsilon_{it} \quad (3)$$

Among them are mediating variables, including information disclosure, agency costs, and green innovation.

4.2. Analysis of empirical results

4.2.1. Descriptive statistical analysis

The basic statistical results for every factor are shown in Table 1. The explanatory variable ESG has a mean of 4.197, a standard deviation of 1.006, and minimum and maximum values of 1 and 8. In general, there are noticeable variations in each company's ESG performance. The explanatory variable DID has a mean of 0.024 and a standard deviation of 0.153. The percentage of businesses that have issued green bonds is quite low. The majority of businesses have comparatively high information disclosure quality, as indicated by the mediating variable information disclosure level index's average value of 3.060 and standard deviation of 0.609. The agency cost indicator's minimum and greatest values are 0.005 and 4.826, respectively, with an average of 0.534 and a

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standard deviation of 0.269. Meanwhile, the average and standard deviation of the green innovation level indicator are 0.390 and 0.609, with lowest and maximum values of 0.000 and 6.848.

Table 1. Descriptive statistics

Variable	N	Mean	SD	Min	Max
ESG	27470	4.197	1.006	1.000	8.000
GPAT	27470	0.390	0.825	0.000	6.848
IR	27470	3.060	0.609	1.000	4.000
ATO	27470	0.534	0.269	0.005	4.826
DID	27470	0.024	0.153	0.000	1.000
Size	27470	22.260	1.308	17.800	28.700
Top1	27470	0.330	0.146	0.018	0.900
Lev	27470	0.400	0.191	0.058	0.891
Growth	27470	0.281	0.613	-0.700	5.157
Board	27470	8.315	1.614	4.000	18.000
Indep	27470	0.379	0.056	0.143	0.800

4.2.2. Analysis of regression results

The estimation findings of the influence of green bond issuance on corporate ESG outcomes are shown in Table 2, where year fixed effects and industry fixed effects are simultaneously controlled. The univariate regression findings are displayed in Column (1), where the DID coefficient is 0.492 and is significant at the 1% level, suggesting that issuing green bonds may greatly enhance an organization's ESG rating performance. The regression findings when additional control factors are added are shown in Column (2), and it is still evident that the DID coefficient is significantly positive at the 1% level, supporting the paper's hypothesis.

Meanwhile, the Size coefficient is 0.261, significant at the 1% level. This indicates that the expansion of the enterprise scale is beneficial for improving the enterprises ESG performance; With a coefficient of 0.448, significant at the 1% level, "Top1" shows that increased ownership concentration is conducive to enhancing corporate ESG performance; the Lev coefficient is -1.356, significant at the 1% level, implying that an increase in the debt-to-asset ratio leads to a decline in ESG performance; the Growth coefficient is 0.022, significant at the 5% level, supporting the view that enhanced firm growth contributes to better ESG performance.; the Board and Indep coefficients are 0.015 and 1.224 respectively, both significant at the 1% level, demonstrating that an increase in the size of the board of directors and the proportion of independent directors significantly promotes ESG performance.

Table 2. Benchmark regression

	(1)	(2)
	ESG	ESG
DID	0.492***	0.164***
	(12.28)	(4.19)
Size		0.261***
		(45.22)
Top1		0.448***
		(11.03)

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Table 2. (continued)

Lev		-1.356***
		(-37.70)
Growth		0.022**
		(2.28)
Board		0.015***
		(3.30)
Indep		1.224***
		(10.03)
Industry Fixed Effects	Controls	Controls
Year Fixed Effects	Controls	Controls
_cons	4.186***	-1.814***
	(702.46)	(-14.11)
N	27468	27468
adj. R^2	0.061	0.155
F	150.820	458.807

t statistics in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

4.2.3. Analysis of mechanism of action

During the process of exploring the mechanism of action, this article elaborates from three aspects: the degree of information disclosure, agency costs, and green innovation.

Table 3. Mediation effect test

	(1)	(2)	(3)	(4)	(5)	(6)
	IR	ESG	ATO	ESG	GPAT	ESG
DID	0.060**	0.140***	0.045***	0.149***	0.093***	0.152***
	(2.52)	(3.68)	(4.56)	(3.82)	(2.95)	(3.90)
IR		0.400***				
		(41.54)				
ATO				0.328***		
				(13.76)		
GPAT						0.128***
						(17.24)
Size	0.179***	0.189***	-0.002	0.261***	0.154***	0.241***
	(50.99)	(32.33)	(-1.27)	(45.48)	(33.08)	(41.21)
Top1	0.491***	0.252***	0.180***	0.389***	0.045	0.442***
	(19.84)	(6.34)	(17.54)	(9.55)	(1.38)	(10.94)
Lev	-0.787***	-1.042***	0.255***	-1.440***	0.136***	-1.374***
	(-35.88)	(-29.19)	(28.01)	(-39.60)	(4.67)	(-38.38)
Growth	0.010	0.019*	-0.051***	0.039***	0.036***	0.018*
	(1.59)	(1.95)	(-20.56)	(3.96)	(4.55)	(1.81)
Board	0.019***	0.007	0.001	0.015***	0.017***	0.013***
	(6.99)	(1.64)	(0.46)	(3.27)	(4.75)	(2.82)
Indep	0.210***	1.141***	-0.108***	1.260***	0.283***	1.188***

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Table 3. (continued)

	(2.82)	(9.63)	(-3.49)	(10.35)	(2.86)	(9.79)
Industry Fixed Effects	Controls	Controls	Controls	Controls	Controls	Controls
Year Fixed Effects	Controls	Controls	Controls	Controls	Controls	Controls
_cons	-1.022***	-1.405***	0.464***	-1.966***	-3.381***	-1.381***
	(-13.05)	(-11.24)	(14.27)	(-15.29)	(-32.52)	(-10.60)
N	27468	27468	27468	27468	27468	27468
adj. R^2	0.145	0.205	0.247	0.161	0.177	0.164
F	580.058	642.454	236.158	427.869	278.861	442.931

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(1) Degree of Information Disclosure

Firstly, the "green attribute" of green bonds determines that their issuers need to make special disclosures regarding the direction of funds and the environmental benefits of the projects. In some cases, a verification report issued by a third-party institution is also required. This kind of information disclosure behavior is not only a requirement of regulatory compliance, but also an important way for enterprises to convey signals of sustainable development to the market. In the ESG evaluation system, information transparency is the core indicator for measuring the quality of a company's sustainable development.

The estimated outcomes of the mediation effect test for the level of information disclosure are shown in columns (1) and (2). As can be observed, the DID coefficient in column (1) is 0.060, which is significant at the 5% level, suggesting that businesses' issue of green bonds significantly promotes their information disclosure. The expected findings of the equation with both DID and IR variables added in column (2) indicate that their coefficients are significant at the 1% level, indicating that increasing the level of information disclosure is beneficial for improving ESG performance. Therefore, it can be concluded that the degree of information disclosure has a remarkable mediating influence in the process of green bond flotation promoting the ESG performance of enterprises, and it is a partial mediation.

(2) Agency Cost

In terms of enterprise agency costs, green bonds issuance involves a strict project screening and fund supervision process [17]. Such external governance mechanisms can effectively curb opportunistic behaviors of management. Meanwhile, the long-term investment nature of green projects will alleviate the short-sighted agency conflicts between shareholders and managers. The reduction of agency costs will enhance the efficiency of corporate social responsibility fulfillment, and thereby have a direct impact on ESG evaluation results.

The estimation findings of the mediating impact of agency expenses are shown in columns (3) and (4). As can be observed, (3) the first column's DID coefficient is 0.045, which is significant at the 1% level, suggesting that issuing green bonds by businesses significantly lowers their agency costs; (4) the second column displays the estimation results when both DID and ATO terms are included in the equation. It is evident that both coefficients are significant at the 1% level, suggesting that lower agency costs contribute to better ESG performance. Thus, it can be inferred that corporate ESG performance facilitation by green bond issuance is partially mediated by agency costs, indicating a significant but bounded mediating effect.

(3) Corporate Green Innovation Capability

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In terms of the green innovation capabilities of enterprises, the targeted use feature of funds raised from green bonds will create a reverse push mechanism for enterprises' R&D investment, promoting them to increase resource allocation in the research and application of green technologies [18].

The estimation results of the mediating influence on green innovation are shown in columns (5) and (6). As can be observed, (5) in the first column, the DID coefficient is 0.093, which is significant at the 1% level, demonstrating that the issuance of green bonds by businesses has a significant promoting effect on their level of green innovation; (6) the estimation results when both DID and GPAT terms are included in the equation are displayed in the second column. It is evident that both coefficients are significant at the 1% level, suggesting that increasing an organization's level of green innovation is beneficial to improving its ESG performance. Therefore, green innovation demonstrates a significant partial mediating effect in the relationship between green bond issuance and enhanced corporate ESG performance.

4.2.4. Robustness tests

To better verify the robustness of the above conclusions, this paper conducts discussions respectively by replacing the explained variables, using the PSM-DID model, drawing placebo test images, and considering the endogeneity issue using the Heckman two-step method.

Table 4. Robustness test

	(1)	(2)	(3)	(4)	(5)	(6)
	ESG_score	ESG_score	ESG	ESG	DID	ESG
DID	0.033***	0.011***	0.211***	0.126**		0.136***
	(12.18)	(4.15)	(3.06)	(2.04)		(3.44)
Size		0.018***		0.385***	0.949***	0.749***
		(45.78)		(14.53)	(28.56)	(6.90)
Top1		0.032***		0.005	-1.180***	-0.175
		(11.62)		(0.03)	(-4.15)	(-1.21)
Lev		-0.097***		-1.726***	2.089***	-0.250
		(-39.43)		(-7.53)	(7.47)	(-1.00)
Growth		0.001*		0.040	-0.475***	-0.228***
		(1.68)		(0.64)	(-5.50)	(-4.03)
Board		0.001***		0.007	-0.055**	-0.014*
		(3.55)		(0.43)	(-2.12)	(-1.78)
Indep		0.085***		1.875***	-2.973***	-0.354
		(10.15)		(3.84)	(-3.62)	(-0.95)
IMR						0.545***
						(4.50)
Industry Fixed Effects	Controls	Controls	Controls	Controls	Controls	Controls
Year Fixed Effects	Controls	Controls	Controls	Controls	Controls	Controls
_cons	4.294***	3.879***	4.465***	-4.682***	-24.752***	-14.782***
	(10526.82)	(442.16)	(98.77)	(-7.65)	(-34.99)	(-5.12)
N	27468	27468	1189	1189	27470	27468
adj. R^2	0.065	0.162	0.095	0.285		0.155
F	148.394	480.379	9.355	45.159		404.268

t statistics in parentheses

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* p < 0.1, ** p < 0.05, *** p < 0.01

(1) Replacement of Explained Variables

The robustness test findings obtained by re-estimating the ESG comprehensive score by substituting a 100-point scale for the explanatory variable ESG rating are displayed in columns (1) and (2). It is evident that the core variable's coefficient is still highly positive at the 1% level, suggesting that issuing green bonds greatly improves businesses' ESG performance.

(2) PSM-DID Model Test

The propensity score values are derived by using DID as the treatment variable in a logistic regression equation with control variables, taking into account the issue of sample selection bias, as shown in columns (3) and (4). The regression result estimation is re-expanded after the data are reprocessed using the closest neighbor matching approach. The conclusion still demonstrates that green bonds offering has a significant promoting effect on the ESG performance of businesses, as can be seen from the fact that the core variable DID coefficient still has significance at least at the 5% level and all coefficient values are positive.

(3) Heckman Two-Stage Method

The robustness test findings for using the Heckman two-step technique to address the endogeneity issue brought on by sample selection bias are shown in columns (5) and (6). The DID and control variable regression results are displayed in column (5). The inverse Mills ratio (IMR) is computed and added to the second-stage regression model based on these predicted values, as indicated in column (6). The fact that the IMR coefficient is significant at the 1% level suggests that sample selection bias is an issue. The finding that the flotation of green bonds has a substantial boosting influence on the ESG performance of firms is further supported by the DID coefficient's continued significance at the 1% level after accounting for this problem concurrently.

(4) Placebo Test

Figure 1 shows the summary results of the coefficients obtained by conducting 500 random assignments on the experimental group of the article and the policy year and then expanding the regression estimation. The image type displayed here is a kernel density image. It can be seen that the random coefficients are all around 0 and far from the true estimated values, once again pointing to the fact that the conclusion of the benchmark regression is not accidental and has good reliability.

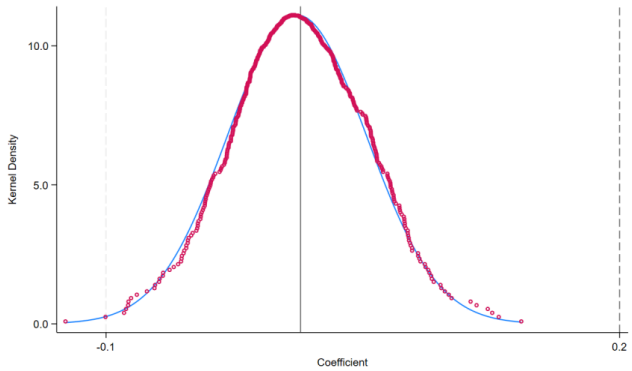

Figure 1. Placebo test

4.2.5. Heterogeneity analysis

In the heterogeneity analysis, this paper conducts relevant discussions respectively from the aspects of property rights nature, industry attributes and the region where it is located. Research has found

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that the effect of issuing green bonds on the ESG evaluation of enterprises does not show a convergent feature in all enterprises, but is deeply dependent on the dual constraints of the enterprise's own attributes and the external environment. Based on this, this paper selects three core dimensions: "whether it is a state-owned enterprise", "whether it belongs to a heavily polluting industry", and "the region where the enterprise is located" to conduct heterogeneity analysis.

Table 5. Heterogeneity analysis

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	SOEs	Non-SOEs	HPEs	Non-HPEs	Eastern Regions	Central Regions	Western Regions
DID	0.324***	0.076	0.195***	0.156***	0.180***	-0.018	0.066
	(5.10)	(1.53)	(2.98)	(3.15)	(3.91)	(-0.18)	(0.58)
Size	0.234***	0.305***	0.243***	0.267***	0.257***	0.259***	0.269***
	(31.24)	(31.26)	(20.90)	(40.28)	(38.90)	(15.09)	(15.04)
Top1	0.484***	0.215***	0.525***	0.425***	0.543***	0.241**	0.215*
	(9.73)	(2.83)	(6.48)	(9.08)	(11.69)	(2.01)	(1.73)
Lev	-1.352***	-1.270***	-1.460***	-1.327***	-1.286***	-1.576***	-1.480***
	(-31.22)	(-19.01)	(-20.63)	(-31.80)	(-30.94)	(-15.20)	(-13.57)
Growth	0.032***	0.002	-0.015	0.029***	0.021*	0.010	0.050*
	(2.61)	(0.11)	(-0.50)	(2.80)	(1.86)	(0.37)	(1.80)
Board	0.012**	0.014**	0.039***	0.005	0.013**	0.026**	0.016
	(1.97)	(2.02)	(4.55)	(0.92)	(2.51)	(2.17)	(1.23)
Indep	1.062***	1.180***	1.832***	0.992***	1.118***	1.363***	1.683***
	(6.59)	(6.08)	(7.40)	(7.08)	(7.80)	(4.09)	(4.78)
Industry Fixed Effects	Controls	Controls	Controls	Controls	Controls	Controls	Controls
Year Fixed Effects	Controls	Controls	Controls	Controls	Controls	Controls	Controls
_cons	-1.136***	-2.796***	-1.960***	-1.736***	-1.703***	-1.806***	-2.229***
	(-6.42)	(-13.21)	(-7.51)	(-11.79)	(-11.50)	(-4.77)	(-5.78)
N	19689	7779	7566	19902	20577	3634	3253
adj. R^2	0.130	0.249	0.130	0.166	0.152	0.192	0.180
F	243.828	197.182	132.084	333.144	338.312	54.520	53.881

t statistics in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

(1) Considering the Impact of Whether the Enterprise is a State-Owned Enterprise

The findings of the heterogeneity study according to the kind of enterprise property rights are shown in columns (1) and (2). With a coefficient value of 0.324, it is evident that the DID coefficient in the sample of state-owned businesses is significant at the 1% level. This variable coefficient is not significant in the non-state-owned business sample. This suggests that the ESG performance of state-owned businesses is more clearly enhanced by the issuing of green bonds.

(2) Considering the Impact of Whether the Enterprise is in a Heavy-Polluting Industry

Column (3) and (4) presents the heterogeneity analysis results based on industry attributes, which are divided into a heavy pollution enterprise sub-sample and a non-heavy pollution enterprise sub-sample. It can be seen that the DID coefficients in both types of samples are significant at the 1% level. The DID coefficient in the heavy pollution enterprise sample is 0.195, while that in the non-heavy pollution enterprise sample is 0.156. The difference between the two is not significant; relatively speaking, the influence is slightly stronger in the heavy pollution enterprise sample.

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(3) Considering the Impact of the Region Where the Enterprise is Located

The findings of the heterogeneity study according to the regions in which the businesses are situated are shown in columns (5), (6), and (7). It is evident that the DID coefficient in the eastern region sample is only significant at the 1% level. The coefficient of this variable is not significant in the samples from the central and western areas. This finding suggests that the ESG performance of businesses in the eastern region is more significantly improved by the issue of green bonds.

5. Conclusion

This study is based on a sample of China's A-share listed companies from 2014 to 2023, with a focus on examining the potential positive influence of green bond offering on corporate sustainable development, particularly regarding ESG performance. Empirical analysis leads to the conclusion that: (1) Compared with enterprises that issue ordinary bonds, green bond issuers demonstrate superior ESG performance. (2) ESG-oriented green bond issuance is mainly achieved by increasing the degree of information disclosure, reducing agency costs, and promoting green innovation in enterprises. (3) In state-owned enterprises, non-heavy polluting enterprises, and in the eastern regions, the role of green bonds in enhancing the ESG performance of enterprises is more significant. The theoretical system related to green finance and sustainable development of enterprises has been further improved. At the same time, it lays a solid foundation for subsequent research on the dynamic changes of ESG in enterprises of different industries and scales under the influence of green bonds [19].

As a result, this article offers recommendations for references from the viewpoints of businesses, investors, and government management. First, businesses should actively participate in the green bond market and take use of the potential presented by green finance. They should improve operational openness, regularly reveal the direction of fund consumption and the environmental advantages of projects, and closely adhere to the standards for disclosing green bond information. Second, while making investment decisions, investors can take into account an organization's ESG performance and the state of its green bond issue. Businesses who issue green bonds and have outstanding ESG performance should be given preference, particularly non-state-owned businesses and those in very polluted industries that have undergone active transformation. Third, the government must create distinct laws for businesses with various characteristics and enhance the green bond market system even more.

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