Can Environmental Disclosure and Green Innovation Alleviate Financing Constraints? Evidence from China

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ABSTRACT

This study investigates the impact of environmental disclosure (ED) and green innovation (GI) on financing constraints (FC) among heavily polluting listed companies in China, using a panel dataset of 7,359 firm-year observations from 2012 to 2023. The findings reveal that ED significantly alleviates FC by reducing information asymmetry and enhancing investor confidence. Importantly, GI also acts as a moderator, strengthening the negative relationship between ED and FC. This suggests that GI not only enhances a firm's environmental responsibility but also amplifies the positive effects of ED on financing conditions. The study further examines the heterogeneous impacts on state-owned enterprises (SOEs) and non-SOEs, finding that while both ED and GI have stronger effects on alleviating FC in SOEs due to their access to policy loans and subsidies, non-SOEs benefit more significantly from ED in reducing information asymmetry. The results highlight the importance of balancing green innovation and financing constraints for sustainable development. Policymakers and financial institutions are also encouraged to support green innovation through improved policies and regulatory frameworks. Future research may explore the sector-specific, regional, and firm-size variations in these relationships to provide more targeted recommendations.

Keywords
Environmental disclosure; Green innovation; Financing constraints; Environmental responsibility; Sustainable development

Introduction

With the high global attention to sustainable development, the performance of companies in environmental responsibility and green innovation has received more and more attention. Environmental disclosure (ED) and green innovation (GI) are not only important manifestations of corporate social responsibility, but may also have a profound impact on companies' financing constraints (FC). Financing constraints constitute a critical barrier to innovation, particularly in contexts where high-risk, high-return investments are essential for technological advancement and competitive differentiation (Yue, et al., 2024). Within China's unique economic framework, financing constraintspose a particularly significant challenge, primarily attributable to the preferential credit allocation favoring state-owned enterprises (SOEs). This systemic bias exacerbates financial constraints for private companies and innovation-driven sectors, creating structural inefficiencies in capital distribution.

Environmental disclosure refers to the disclosure by a company to its stakeholders of information on its activities and performance in environmental protection, resource utilization and environmental management. Good environmental disclosure can enhance investor confidence in the future sustainable development of a company and reduce information asymmetry, thus bringing more financing opportunities to companies (Yao et al., 2019; Shen et al., 2022). In recent years, China has made significant progress in corporate environmental disclosure. Such disclosure not only helps to enhance the social image of companies, but also attracts the attention of more green investors through transparent information transfer, thereby alleviating financing constraints.

The intensifying environmental problems in recent years have made green innovation a key factor in promoting sustainable development (Wang, 2025). However, companies often face financing difficulties in the pursuit of green innovation, which not only restricts the increase of R&D investment, but also affects the promotion and application of green technologies. Therefore, studying the impact of ED and green innovation on FC is of great theoretical and practical significance for promoting sustainable development of companies. Studies have shown that financing constraints can significantly hinder green innovation activities, especially in heavy polluting industries, and this effect is more obvious (Zhao et al., 2024). Therefore, how to alleviate the financing constraints of green innovation through policy support and market mechanisms has become an important topic for current research.

Over recent years, the impact of ED and green innovation on FC has been extensively studied in both academic and practical circles. On the one hand, ED alleviates companies' financing constraints by reducing information asymmetry and enhancing investor confidence. On the other hand, green innovation can reduce financing costs and attract more green financial resources by enhancing the economic efficiency and social image of companies (Bhatti et al., 2022; He et al., 2024). However, the high investment and uncertainty of green innovation also make companies face higher risks and costs in the financing process (Zhang et al., 2020; Yu et al., 2021). Accordingly, financing constraints need to be balanced between environmental disclosure and financing constraints when promoting green innovation in order to achieve sustainable development. In this study, we will discuss the connotation of environmental disclosure and green innovation, the influence mechanism of the two on financing constraints, and the latest empirical research results, with a view to providing references for related research and practice.

Literature Review and Hypothesis Development

Environmental disclosure applies to the communication by companies to society regarding their environmental management practices, pollution emissions, and sustainable development efforts (Zhou et al., 2022). Based on information asymmetry theory, company disclosure inhibits adverse selection in the capital market by reducing the information gap, while stakeholder theory further views disclosure as the fulfilment of a company's responsibility to multiple actors, both of which point to the key role of disclosure in reducing transaction costs and facilitating the allocation of resources in a beneficial way (Bergh et al., 2019; Yang et al., 2024). Environmental disclosure can alleviate companies' financing constraints through a variety of mechanisms (Xu & Jamal, 2024). Firstly, high-quality environmental disclosure can reduce the information asymmetry between investors and enterprises, enhance investors' trust in enterprises, and thus reduce the financing cost of companies (Feng et al., 2024; Yang et al., 2024). Second, environmental disclosure can enhance the social image and reputation of companies and attract more attention from green investors and financial institutions (Bai et al., 2022). For example, studies have shown that environmental information disclosure has a significant negative correlation with financing constraints, i.e., the higher the level of environmental disclosure, the lower the financing constraints (Luo et al., 2019; Meng et al., 2022). Furthermore, environmental disclosure can also prompt companies to accept the dual supervision of the government and the capital market, and promote companies to actively seek green transformation and upgrading. Based on the above research, this study proposed hypothesis 1.

Hypothesis 1: Environmental disclosure alleviates financing constraints.

Green innovation refers to environmentally friendly innovation activities adopted by companies in terms of products, technologies and management. Green innovation not only enhances companies environmental performance but may also mitigate financing constraints by improving competitiveness and market reputation (Zhao et al., 2024). Companies' financing constraints are also significantly affected by green innovation. On the one hand, green innovation may decrease a company's environmental pollution expenses and enhance resource utilization efficiency, thereby enhancing the company's economic performance and market competitiveness. On the other hand, green innovation projects usually have high social value and policy support, which can attract more green financial resources. However, green innovation also faces some challenges, such as long R&D cycles, high input costs and non-transparent information, which may lead to greater companies' financing constraints in the financing process (Wang, 2022; Wang, 2025). However, research shows that green innovation and financing constraints are significantly negatively correlated, i.e., the higher the level of green innovation, the lower the companies' financing constraints (Qian, 2024). Therefore, this study proposed Hypothesis 2.

Hypothesis 2: Green innovation is negatively associated with financing constraints.

While existing literature has extensively examined the individual roles of environmental disclosure (ED) and green innovation (GI) in mitigating financing constraints (Yu et al., 2021; Yang et al., 2024), few studies have explored the interactive effects between these two mechanisms. Specifically, the moderating effect of GI on the connection between ED and finance restrictions is inadequately investigated. Green innovation serves as a demonstration of corporate environmental accountability and may help mitigate the impact of ED on FC by improving technological proficiency and market recognition. For example, green innovation can enhance technological innovation capability, which in turn improves its financing environment (Yu et al., 2021; Wang, 2022). In addition, green innovation may also enhance investor confidence in companies by reducing their environmental risks. There is a significant interaction between ED

and GI, and this interaction can further alleviate financing constraints. Specifically, ED can send positive signals to the market about a company's green innovation and enhance investor confidence in the company, thus reducing the company's financing costs. At the same time, green innovation can bring more economic gains and social reputation for companies, further enhancing the willingness and quality of companies to disclose environmental information. However, current research predominantly treats ED and GI as independent determinants, neglecting their synergistic potential. To address this gap, we proposed that GI serve as a positive moderator, reinforcing the negative correlation between ED and financing constraints. Specifically, companies with higher GI capabilities are likely to leverage ED more effectively to reduce financing costs, as their innovation outcomes provide tangible evidence to validate disclosed environmental commitments. Based on this, this study proposed hypothesis 3.

Hypothesis 3: Green innovation moderates the alleviate effect of environmental disclosure on financing constraints.

Based on the above literature review and research hypotheses, the conceptual framework of this study is shown in Figure 1.

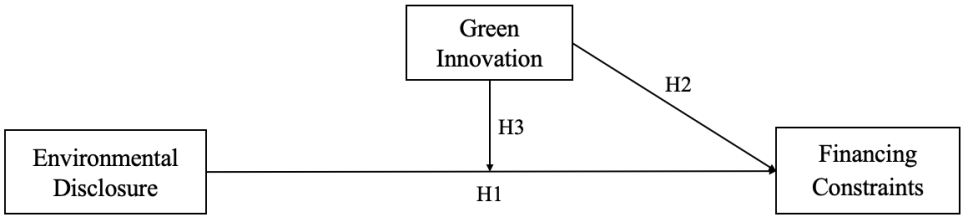

Figure 1 Conceptual framework

Research Methodology

Sample Selection and Data Sources

This analysis selects 7,359 observations of Chinese listed companies which release environmental information from 2012 to 2023 from an unbalanced panel dataset. The environmental disclosure data are sourced from the annual reports, social responsibility reports, environmental reports, and sustainability reports of publicly listed Chinese companies. Additional data, encompassing control factors, were sourced from the Chinese Stock Market Accounting Research (CSMAR) database. Furthermore, all continuous variables have undergone winsorization at the 1st and 99th percentiles. The following companies were excluded from the first sample screening in this study: (1) listed companies not classified as heavy polluting companies; (2) ST (Special Treatment) and *ST listed companies; and (3) listed companies with incomplete data.

Variable Design

The dependent variable in this study is the KZ index, which reflects the degree of financing constraints faced by companies. Kaplan & Zingales (1997) constructed a financial constraint index, which is initially used to predict the likelihood that a company may face financial constraints. The index uses financial ratios and firm characteristics to generate an index reflecting the extent to which a company faces financial constraints through a linear regression model. In this study, we construct a KZ indicator to measure the degree of financial constraints using the accounting information of listed companies in China following the methodology proposed by Kaplan & Zingales (1997) and Akbar et al. (2021). The higher the KZ index, the higher degree of financing constraints. The calculation method of KZ index is shown in model (1).

$$KZ_{i,t} = \alpha_1 \frac{CF_{it}}{ASSET_{it-1}} + \alpha_2 LEV_{it} + \alpha_3 \frac{DIV_{it}}{ASSET_{it-1}} + \alpha_4 \frac{CASH_{it}}{ASSET_{it-1}} + \alpha_5 Q_{it} \quad (1)$$

In this model, i denotes the company and t represents the year. CF represents operating net cash flow, $ASSET_{it-1}$ represents total assets at the beginning of the year, LEV represents asset-liability ratio, DIV represents cash dividends, CASH represents cash holdings, and Q represents Tobin's Q.

The ED Index consists of five categories of items: environmental management, environmental regulations and certification, environmental performance and governance, environmental liabilities and environmental vehicle (refer to Table 1). The maximum score for complete and full disclosure across all five categories is 44. The scores for all items are added together to give each company a total score that reflects its overall ED level.

Table 1 Environmental Disclosure Evaluation System

Indicators		Scoring rules
Environmental Management	Environmental protection concept Environmental goal Environmental protection management system Environmental education and training Environmental protection special action Environmental incident emergency response mechanism Environmental honor or reward Three simultaneities	The company discloses the information by assigning a value of 1, otherwise it is 0.
Environmental Regulation and Certification	Key pollution monitoring unit Pollutant emission standard Sudden environmental accident Environmental violation Environmental petition case Pass ISO14001 Pass ISO9001	
Environmental Performance and Governance	Waste gas emission reduction Waste water emission reduction Dust and smoke reduction Solid waste utilization and disposal Noise, light pollution and radiation governance Cleaner production implementation	0 = no description; 1 = qualitative description; 2 = quantitative description (monetary/numerical type description)
Environmental Liabilities	Waste water emission COD emission SO2 emission CO2 emission Smoke and dust emission Industrial solid waste emission	
Disclosure Vehicle	Annual report	1=Yes; 0=No; Whether listed companies disclose environment-related information in the annual reports
	Social responsibility report	1=Yes; 0=No; Whether listed companies disclose environment-related information in the social responsibility report
	Environmental report	1=Yes; 0=No; Whether listed companies disclose environmental report

Following Yue et al. (2024), this study focuses its research attention on the total number of green patent applications as they reflect long-term commitment to sustainable technology and practical innovation. In addition, according to relevant empirical studies (Zhao et al., 2023; Li & Fu, 2024), the selected control variables reflect company size, growth capacity, profitability and corporate governance. The specific variables are defined as shown in Table 2.

Table 2 Definitions of the variables.

Variable type	Variable name	Abbreviation	Operational definition
Dependent variable	Financing constraints	KZ	A five-factor model based on Kaplan & Zingales (1997)
Independent variable	Environmental disclosure	ED	Percentage of company's environmental disclosure score in total environmental disclosure score
Moderator variable	Green innovation	GI	Ln (number of utility patents + number of invention patents +1)

Control variables	Firm size	Fsize	The natural log of total assets
	Return on assets	ROA	Net income divided by total assets
	Investment opportunity	Growth	Current year's total assets / previous year's total assets) - 1
	Ownership nature	SOE	1 for state-owned companies, 0 for non-state-owned companies
	CEO-duality	Duality	Dummy variable equals 2 if the same person holds CEO and the chairman positions, otherwise 1
	Board size	Bsize	Total number of directors on the board

Model Specification

This study was aimed at investigating the impact of ED influence on the FC of listed companies in China, along with the moderating effect of green innovation on the link between ED and FC. This study utilized a quantitative methodology to experimentally assess the proposed hypotheses, as FC were affected by various factors, including ED and green innovation. We used an individual fixed-effects model to explore the relationship between ED, GI and FC. This study constructed a multivariate linear regression analysis model in fulfilling the research purposes:

$$KZ_{i,t} = \alpha_0 + \alpha_1 ED_{i,t} + \alpha_2 Control_{i,t} + \varepsilon_{it} \quad (2)$$

$$KZ_{i,t} = \alpha_0 + \alpha_1 GI_{i,t} + \alpha_2 Control_{i,t} + \varepsilon_{it} \quad (3)$$

$$KZ_{i,t} = \alpha_0 + \alpha_1 ED_{i,t} + \alpha_2 GI_{i,t} + \alpha_3 ED_{i,t} * GI_{i,t} + \alpha_4 Control_{i,t} + \varepsilon_{it} \quad (4)$$

In the models, i signifies the company and t specifies the year. Model (2) analysed the relationship between ED and financing constraints, Model (3) investigated the impact of green innovation on financing constraints, and Model (4) incorporated ED items and green innovation into Model (2) to assess the moderating effect of green innovation.

Findings and Discussions

Descriptive Statistics

Table 3 presents the descriptive statistics of the variables used in this study. The sample companies generally face some degree of financing constraints (KZ) with a mean value of 1.595. The minimum value of the KZ index is -3.939, the maximum value is 5.694, and the standard deviation is 1.744. The level of environmental disclosure (ED) is average, with a mean value of 0.313. The minimum value of the EAID is 0.0238, and the maximum value is 0.786, with a standard deviation of 0.202. This indicates that, although the level of ED varies widely, the distribution of the level of ED is relatively concentrated. The mean value of green innovation (GI) is low at 0.268, reflecting the relatively low level of innovative activities.

Table 3 Descriptive statistics

Variable	N	mean	max	p50	min	sd
KZ	7359	1.595	5.694	1.770	-3.939	1.744
ED	7359	0.313	0.786	0.286	0.0238	0.202
GI	7359	0.268	5.170	0	0	0.626
Fsize	7359	22.53	28.64	22.28	18.75	1.404
ROA	7359	0.0351	0.644	0.0346	-1.395	0.0737
Growth	7359	0.108	1.004	0.0699	-0.240	0.192
SOE	7359	0.408	1	0	0	0.491
Duality	7359	0.246	1	0	0	0.431
Bsize	7359	8.715	15	9	5	1.732

Correlation Analysis

Table 4 shows the Pearson and Spearman correlations between ED, GI, FC and all control variables. The Spearman correlation coefficients are shown above the main diagonal and the Pearson correlation coefficients are shown below the diagonal. The Pearson correlation coefficients indicate that there is a significant negative correlation between ED (coefficient = -0.028), ROA (coefficient = -0.563), growth capacity (coefficient = -0.187), and duality (coefficient = -0.083) and FC. A similar pattern was observed for the Spearman correlation coefficient. In addition, there is no significant correlation between green innovation and FC, thus further analyses are still needed.

In the correlation analysis, all correlation coefficients range from -0.5 to 0.5, with the exception of the association between ROA and KZ, which is -0.563. Nonetheless, the inclusion of ROA as a control variable in the regression model proved this association inconsequential to the results. This result demonstrates that the Pearson and Spearman correlation coefficients produced remarkably comparable outcomes, indicating a significant association between the majority of control variables and FC. The average Variance Inflation Factor (VIF) is 1.25, suggesting that multicollinearity among variables is not a significant issue.

Table 4 Correlation Matrix Results

	KZ	ED	GI	Fsize	ROA	Growth	SOE	Duality	Bsize
KZ	1	-0.025**	0.004	0.211***	-0.658***	-0.182***	0.261***	-0.082***	0.103***
ED	-0.028**	1	0.237***	0.390***	0.066***	0.011	0.127***	-0.056***	0.118***
GI	0.006	0.248***	1	0.223***	0.024**	0.008	0.121***	-0.078***	0.117***
Fsize	0.156***	0.407***	0.317***	1	-0.051***	0.009	0.408***	-0.208***	0.285***
ROA	-0.563***	0.068***	0.026**	0.036***	1	0.380***	-0.205***	0.052***	-0.036***
Growth	-0.187***	-0.013	-0.021*	-0.005	0.330***	1	-0.194***	0.093***	-0.044***
SOE	0.243***	0.136***	0.151***	0.418***	-0.117***	-0.188***	1	-0.311***	0.285***
Duality	-0.083***	-0.054***	-0.082***	-0.198***	0.020*	0.085***	-0.311***	1	-0.169***
Bsize	0.095***	0.124***	0.145***	0.346***	0.012	-0.048***	0.307***	-0.164***	1

Regression Analysis

Table 5 depicts the findings of the model, encompassing both control and independent variables. The analyses depend on equations (2), (3), and (4). The findings of the fixed effects model shown in Table 5 indicate that the impact of ED on FC is significantly negative at the 1% level (coefficient of -0.509). Hypothesis 1 is verified. Meanwhile, the effects of green innovation and the interaction term (ED*GI) on FC were examined using the fixed effect model. Model (2) discovers that the coefficient of green innovation is -0.0585, signifying a mitigating effect of green innovation on FC at the 10% significance level. Hypothesis 2 is verified. In addition, in model (3), the interaction term ED*GI has a significant negative effect on FC at the 10% level. This result indicates that green innovation has a significant moderating effect on the relationship between ED and FC, thus testing Hypothesis 3.

This study finds that ED can significantly alleviating companies' FC, which is aligned with the findings in the existing literature that high-quality environmental information disclosure can reduce information asymmetry and enhance investor confidence (Yao et al., 2019; Yang et al., 2024). In addition, the study also finds that green innovation has a significant alleviating effect on financing constraints, which suggests that investment by companies in green technology research and development, as well as its implementation, not only improves their environmental performance but also mitigates financial challenges by reinforcing market competitiveness and securing legislative backing.

Furthermore, analysis shows that green innovation plays a significant moderating role between ED and FC. Specifically, a high level of green innovation enhances the alleviating effect of ED on FC. This finding indicates that green innovation serves as both a demonstration of corporate environmental responsibility and a crucial method for companies to improve market recognition and financing capabilities. Through green innovation, companies are able to convey to the market their long-term commitment to sustainable development, thereby attracting more attention and support from investors.

Table 5 Regression analysis

Variable	(1) KZ	(2) KZ	(3) KZ
ED	-0.509***		-0.483***
	(-4.98)		(-4.70)
GI		-0.0585*	-0.0308
		(-1.86)	(-0.94)
ED*GI			-0.198*
			(-1.78)
Fsize	0.107***	0.0488*	0.109***
	(3.66)	(1.84)	(3.71)
ROA	-8.126***	-8.132***	-8.109***
	(-39.16)	(-39.12)	(-39.05)
Growth	-0.525***	-0.491***	-0.528***
	(-7.00)	(-6.57)	(-7.04)
SOE	0.259**	0.235**	0.267**
	(2.40)	(2.17)	(2.47)
Duality	-0.0505	-0.0503	-0.0494
	(-1.10)	(-1.09)	(-1.07)
Bsize	-0.0189	-0.0128	-0.0202
	(-1.28)	(-0.87)	(-1.37)
_cons	-0.243	0.878	-0.265
	(-0.37)	(1.43)	(-0.40)
N	7359	7359	7359
F	275***	271***	214***
r2	0.231	0.228	0.232
r2_a	0.116	0.113	0.116

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Further Analysis

Chinese listed companies can be categorized by ownership into state-owned enterprises (SOEs) and non-state-owned enterprises (non-SOEs). We categorize our sample companies by ownership to investigate whether there is heterogeneity in the moderating effect of ED on the reduction of FC and green innovation in different categories of listed companies. Tests were conducted for both categories of companies (state-owned and non-state-owned) utilizing equations (2), (3) and (4). The findings presented in Table 6 demonstrate that the alleviating effect of ED on FC is stronger among state-owned companies. State-owned companies are supported by the government and have a significant advantage over private companies in terms of policy loans, local government grants, and bank funding, thus reducing FC.

However, private companies depend on their own credit for funding and encounter more FC due to information asymmetry between creditors and borrowers. The ED mandates the disclosure of increasingly comprehensive corporate information, resulting in a heightened effect of the ED on the financing limits of non-state companies. Interestingly, a similar pattern is observed in green innovation and the interaction term ED*GI. Specifically, the greener patents a company has, the smaller the companies' financing constraints are for state-owned firms. In addition, the moderating effect of GI has a greater alleviating effect on state-owned companies' financing constraints.

Table 6 Further analysis

Variable	(1) SOE-0 KZ	(2) SOE-1 KZ	(3) SOE-0 KZ	(4) SOE-1 KZ	(5) SOE-0 KZ	(6) SOE-1 KZ
ED	-0.260*	-0.657***			-0.247	-0.585***
	(-1.67)	(-4.89)			(-1.58)	(-4.28)
GI			-0.0295	-0.0883**	-0.0323	-0.0353
			(-0.61)	(-2.19)	(-0.66)	(-0.81)

ED*GI					0.198	-0.294**
					(0.98)	(-2.22)
Fsize	0.231***	-0.116***	0.200***	-0.189***	0.230***	-0.118***
	(5.61)	(-2.69)	(5.52)	(-4.70)	(5.56)	(-2.74)
ROA	-7.525***	-8.577***	-7.518***	-8.595***	-7.529***	-8.525***
	(-26.98)	(-27.85)	(-26.95)	(-27.81)	(-26.99)	(-27.67)
Growth	-0.542***	-0.563***	-0.522***	-0.542***	-0.541***	-0.572***
	(-5.89)	(-4.15)	(-5.73)	(-3.99)	(-5.89)	(-4.23)
Duality	-0.0368	-0.0593	-0.0366	-0.0657	-0.0372	-0.0567
	(-0.64)	(-0.73)	(-0.64)	(-0.81)	(-0.65)	(-0.70)
Bsize	-0.0720***	0.00554	-0.0692***	0.0110	-0.0721***	0.00185
	(-3.07)	(0.29)	(-2.95)	(0.58)	(-3.07)	(0.10)
_cons	-2.768***	5.225***	-2.175***	6.677***	-2.750***	5.320***
	(-3.08)	(5.22)	(-2.66)	(6.99)	(-3.04)	(5.31)
N	4355	3004	4355	3004	4355	3004
F	166***	164***	165***	160***	124***	124***
r2	0.212	0.271	0.212	0.266	0.212	0.273
r2_a	0.071	0.174	0.070	0.168	0.071	0.176

t statistics in parentheses
* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Conclusion

Based on panel data of heavy polluting listed companies in China, this study provides an in-depth investigation of the effects of environmental disclosure (ED) and green innovation (GI) on companies' financing constraints (FC) and their interaction mechanisms. The results show that ED can significantly alleviate FC, which is mainly achieved by reducing information asymmetry, enhancing investor confidence, and improving corporate social image. Moreover, green innovation also has a significant alleviating effect on FC. Additionally, green innovation plays a significant moderating role between ED and FC, which further strengthens the alleviating effect of ED on FC.

Furthermore, in the heterogeneity analysis, this study finds that there is a significant distinction between state-owned companies and private companies in terms of the effects of ED and GI on financing constraints. State-owned companies hold inherent advantages through policy loans, government subsidies, and financial backing from banks, hence amplifying the mitigating impact of ED on FC. However, for private companies' financing constraints are more critical to be alleviated by environmental disclosure as their sources of finance rely more on market credit and the information asymmetry problem is more prominent. In addition, the moderating effect of green innovation is more significant in SOEs, which may be related to SOEs' advantages in resource acquisition and policy support. This result suggests that companies need to fully consider their market environment when formulating green development strategies in order to achieve a win-win situation between environmental responsibility and economic benefits.

Above all, environmental disclosure and green innovation have a significant alleviating effect on financing constraints, and the interaction between the two can further enhance this effect. In the context of global sustainable development, companies should actively strengthen environmental disclosure and green innovation investment to reduce financing costs and enhance market competitiveness, especially private companies. At the same time, the government and financial institutions should also increase their support for green innovation, improve relevant policies and regulatory mechanisms, and promote companies to achieve coordinated development of the economy and the environment. For example, regulators should refine the Green Credit Guidelines and implement a special green innovation credit line for private companies to lower their threshold for green project financing. The Ministry of Finance and local governments could jointly launch a 'green innovation interest rate subsidy fund' to provide 'double-linked' subsidies to private companies for green R&D investments. Future research can further explore the heterogeneous impacts of ED and GI in different regions and in different contexts, and provide more targeted recommendations for policymaking and company practices.

Conflict of Interest

The authors declare that there is no conflict of interest regarding the publication of this paper.

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