Research on the Impact of Manufacturing Enterprises' ESG Performance on Green Innovation

Jiajun Xu

Harbin University of Commerce, Harbin, Heilongjiang, China
60945054@qq.com

Abstract. This study aims to explore the impact effect and internal mechanism of ESG performance of manufacturing enterprises on green innovation, and to analyze whether ESG performance can effectively drive the green transformation of manufacturing enterprises under the background of the "carbon neutrality" strategy. Based on the sample of manufacturing listed companies in Shanghai and Shenzhen A-shares from 2013 to 2023, this paper constructs a non-equilibrium panel data model and uses fixed effect regression, two-step mechanism test, instrumental variable method (2SLS), and various robustness test methods to systematically examine the impact of ESG performance on green innovation. The research shows that the ESG performance of manufacturing enterprises has a significant positive promoting effect on green innovation. ESG performance indirectly promotes green innovation through two paths: alleviating financing constraints and enhancing capital market attention. This enriches the theoretical research on the relationship between ESG and green innovation and expands the mechanism analysis framework in the manufacturing context. It provides empirical support for enterprises to formulate differentiated ESG strategies in different situations.

Keywords: ESG; Green innovation; financing constraints; capital market attention

1 Introduction

Over the past 30-plus years of China's economic development, the manufacturing industry has always played a pivotal role and served as a crucial foundation for maintaining high-speed economic growth, enabling the country to achieve unimaginable economic accomplishments. However, it has also led to significant damage to China's ecological environment with the continuously deteriorating environmental conditions. In China, taking a green growth path for economic development and then achieving regional green transformation is the only way for China's sustainable development (Wang, 2016). As the most dynamic core driving force for current green and low-carbon development, green innovation is the key means for manufacturing enterprises to complete their green transformation. After the proposal of China's "dual carbon" strategic goals, the government has significantly increased its support for the green transformation of manufacturing enterprises and clearly emphasized the vigorous

L. W. Koon et al. (eds.), *Proceedings of the 2026 7th International Conference on Management Science and Engineering Management (ICMSEM 2026)*, Advances in Economics, Business and Managem
https://doi.org/10.2991/978-94-6239-758-3_37

development of green innovation. Compared with traditional technological innovation, green innovation, as a new type of innovation approach, can ensure environmental protection while promoting economic development and achieving green economic growth. Its status in China's manufacturing industry is becoming increasingly important (Yuan, 2019). Therefore, how to enhance the green innovation of manufacturing enterprises has gradually become a focus of concern for the country and society.

The ESG performance of enterprises integrates three dimensions: Environmental, Social, and Governance. As a comprehensive framework advocating responsible investment and sustainable operation, it is regarded as an important market governance mechanism guiding and empowering enterprises to undergo green transformation. The outstanding ESG performance of enterprises has a significant promoting effect on their green innovation, and scholars have explored the relationship between this two conception. Zhao and Li(2024), based on a quasi-natural experiment, found that ESG ratings can significantly increase the quantity and quality of green technological innovation in enterprises through three channels: reducing agency costs, alleviating financing constraints, and enhancing the environmental awareness of management. Li et al. (2024), from the perspective of internal investment by enterprises, discovered that ESG performance can also promote green technological innovation in enterprises by strengthening environmental investment and improving the quality of internal control. At the supply chain level, some scholars have found that the ESG advantages of downstream customers can motivate midstream enterprises to engage in green innovation by enhancing their green awareness and increasing commercial credit support. Moreover, when midstream enterprises are more dependent on major customers, it is more conducive to promoting green innovation in midstream enterprises (Yan et al., 2024).

However, while existing research has achieved fruitful results, there remains considerable room for in-depth exploration. Most of the literature, in the examine about the green innovation effect of ESG, tends to adopt a universal analytical framework and fails to delve deeply into the specific context of particular industries for detailed analysis. As a pillar of the national economy and a significant source of carbon emissions, the manufacturing industry has a unique industrial ecosystem that constitutes an indispensable macro background for enterprise innovation. Based on the foundation, this study focuses on the manufacturing sector. Using unbalanced panel data of manufacturing enterprises from 2013 to 2023, systematically investigates the relationship between ESG and green innovation performance in the manufacturing industry, deeply analyzes the mechanism effects of financing constraints and capital market attention, and further explores their heterogeneous impacts, with the aim of providing practical experience and inspiration for green innovation-oriented manufacturing enterprises.

2 Hypothesis Development

2.1 Direct Impact

Green innovation refers to technological innovation activities oriented towards environmental protection, which aims to reduce environmental pollution, lower energy

consumption, and enhance the efficiency of resource utilization. The ESG rating of enterprises, as a comprehensive framework for sustainable development, can provide internal driving forces and external support for enterprise green innovation through multiple theoretical mechanisms. In the theory of technological innovation, the emphasis is on how to achieve maximum output at the lowest cost while maintaining high efficiency. ESG introduces a new set of non-economic selection criteria. In environmental standards, it can consider whether the technology can significantly reduce carbon emissions, pollution, and resource consumption; in social standards, it can consider whether the technology has a positive impact on society (such as community health and labor rights) throughout the supply chain cycle; in governance standards, the decision-making process can be more systematical to consider these environmental and social impacts. In the manufacturing industry, when enterprises carry out technological innovation, they can fully consider the concept of sustainable development (Dai&Yang, 2022), setting a new problem domain and direction for technological innovation, focusing the attention of R&D personnel on green and social issues, and promoting the development of enterprise green innovation.

The resource dependence theory suggests that external resources are indispensable for the survival and development of an organization. For manufacturing enterprises, the implementation of ESG is not merely a passive response to expectations from various parties, but an active and strategic behavior aimed at ensuring, stabilizing, and expanding the key resources necessary for their survival and development. Actively disclosing ESG-related information can demonstrate to outside its attention on the environment, its responsibility to society, and its control over management. Investors and the government will be more interested in supporting such responsible and transparent enterprises (Wang&Jiang 2024).

The principal-agent theory points out that when the ownership and management rights of an enterprise are separated, management differences may arise due to their different profit objectives. The ESG disclosure mechanism can realign the interests of the principal and the agent, improve the internal governance level of the enterprise, and make the agent's performance in environmental and social aspects transparent and quantifiable, thereby promoting green innovation (Dai &Yang, 2022). On the other hand, managers may pursue short-term benefits and abandon high-risk projects that are fit for the company in the long run, like green innovation. The ESG management mechanism forces managers to take environmental and social factors of the enterprise into account, thereby reducing the short-sighted behavior of senior executives (He &Tian, 2013).

H1. The ESG performance of manufacturing enterprises can directly promote the improvement of green innovation.

2.2 Mechanism Analysis

When enterprises get limitation from external capital market, they get financing constraints. In the manufacturing industry, the development of green technologies, the purchase of environmental protection equipment, and the construction of clean production lines all require huge upfront capital investment. The level of financing costs

significantly affects the obstacles enterprises face when engaging in new attempt like green innovation. Excellent and long-term ESG performance can effectively help enterprises alleviate financing constraints (Zeng Chunhua). because of the high professionalism and uncertainty of green innovation, external investors find it difficult to accurately estimate its value and risks, which lead to severe information asymmetry. High-quality ESG information disclosure and performance can reveal the company's policies and performance data from the aspects of environmental performance (E), social responsibility (S), and corporate governance (G), greatly increasing information transparency and showing investors the company's investment and achievements in sustainable development, making investors, especially those with green and environmental awareness, willing to pay a high premium for enterprises with high ESG ratings (Pástor L, 2021).

Manufacturing enterprises can attract the focused attention of institutional analysts and investors by improving their ESG performance. According to the reputation theory, outstanding ESG performance can convey to the public a signal of the enterprise's emphasis on green transformation, effectively enhancing the enterprise's reputation. This not only improves the enterprise's evaluation among consumers but also catches the attention of institutional investors and analysts (Xu, 2023). Compared to the highly homogeneous traditional financial information, ESG provides a unique perspective on enterprise risks, management quality, and social legitimacy. For investors and analysts seeking alpha returns, ESG data is an important tool for identifying undervalued stocks and avoiding high-risk financing. Enterprises with excellent ESG performance, especially those actively transforming in the manufacturing industry, will attract more analysts to write research reports and more institutional investors to conduct research.

Through this attention, enterprises can get more financing convenience from the outside. Positive research reports will convey optimistic signals to the market, reduce information asymmetry, attract more investors, thereby raising stock prices and lowering equity financing costs. Institutional investors' purchases and long-term holdings provide a stable source of funds for enterprise green innovation. At the same time, it also can increase internal supervision pressure on the enterprise, managements tend to invest resources in green technology research and development that is costly but can bring higher and longer-term returns (Porter&Zhao, 1995).

H2. The ESG performance of manufacturing enterprises can enhance their green innovation by alleviating financing constraints.

H3. The ESG performance of manufacturing enterprises can enhance their green innovation through increasing the attention of the capital market.

3 Materials and Methods

3.1 Model Specification

To verify H1, this study establishes the following benchmark regression model for tests:

$$GI_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t} + \sum_k \alpha_k \ Controls_{i,t} + \sigma_t + \lambda_i + \varepsilon_{i,t} \quad (1)$$

In the formula，$GI_{i,t}$ represents the green technological innovation level of enterprise i in the t-th year; $ESG_{i,t}$ represents the ESG rating of enterprise i in the t-th year; *Controls* represent the aforementioned control variables; σ_t & λ_i , respectively represent the time fixed effect and the individual fixed effect; $\varepsilon_{i,t}$ is the random disturbance term.

In order to verify H2 and H3, this paper incorporates financing constraints into the analytical framework. By borrowing from Jiang Ting's (2022) research, it adopts a two-step method to explore the internal mechanism of how financing constraints affect the ESG rating of enterprises and the green innovation of enterprises. Through the analysis of existing literature, it is known that the mediating variables, financing constraints and capital market attention, have a significant effect on the explained variable, enterprise green innovation. Therefore, the following model is constructed:

$$M_{i,\mathrm{t}} = \alpha_0 + \alpha_1 ESG_{i,\mathrm{t}} + \sum_{\mathrm{k}} \alpha_k \ Controls_{\mathrm{i,t}} + \sigma_{\mathrm{t}} + \lambda_{\mathrm{i}} + \varepsilon_{\mathrm{i,t}}$$

$$GI_{i,\mathrm{t}} = \alpha_0 + \alpha_1 ESG_{i,\mathrm{t}} + \ \alpha_2 M_{i,\mathrm{t}} + \sum_{\mathrm{k}} \alpha_k \ Controls_{\mathrm{i,t}} + \sigma_{\mathrm{t}} + \lambda_{\mathrm{i}} + \varepsilon_{\mathrm{i,t}} \quad (2)$$

In the formula, $M_{i,\mathrm{t}}$ represents the mediating variable, and the meanings of other variables are the same as those in Equation (1).

3.2 Variable Definition

Table 1 describes all the variables I used in this study:

Dependent variable: Green innovation. In the existing literature, green invention patents can reflect the quality of green innovation better. This paper uses the logarithm of the sum of green invention applications + 1 as an indicator to measure the green innovation (GI) of enterprises, which enables a more detailed understanding of the impact of ESG on innovation quality.

Independent variable: ESG rating of manufacturing enterprises. This paper adopts the research idea of Li & Zheng (2022), selecting the Huazheng ESG rating index with wide coverage and timeliness to measure the ESG performance of enterprises.

Mediating variable: The mediating variable is financing constraint (SA) and capital market attention (Att). Here, the financing constraint is based on the research of Hadlock and Pierce (2010), measured by the absolute value of the SA index. The larger the absolute value of the SA index, the greater the financing constraint faced by the enterprise. The capital market attention follows the approach of Liu et al. (2025), using the number of analysts tracking the same listed company as the measurement indicator of capital market attention, that is, taking the logarithm of the number of analysts focusing on the same listed company.

Control variables: To control for other interfering factors that may affect the relationship between variables, following the approach of Wang Yun et al. (2017), this study introduces several control variables. Considering the impact of firm size (Size), larger firms usually have more resources to support innovation activities, and the logarithm of total assets is used as the measurement standard. Return on equity (ROE)

is measured by the ratio of net assets to total assets; the debt-to-asset ratio (Lev) is measured by the ratio of total liabilities to total assets of the enterprise; firm growth (Growth) is measured by the ratio of current year's operating income to the previous year's operating income minus 1; the fixed assets (fixed) indicator is measured by the ratio of net fixed assets to total assets; firm age (Firmage) is measured by the number of years since the firm's establishment; the ownership structure of the firm can influence its own investment in major strategic decisions, and the total shareholding ratio of the top three shareholders (Top3) is used as the measurement indicator; the combined position of the chairman and the general manager (Dual) is measured by whether the chairman and the general manager hold the positions concurrently, taking 1 if they do and 0 otherwise.

Table 1. Variable declaration

Variable Type	Variable Name	Variable Symbol	Variable Definition
Dependent Variable	Green Innovation	GI	Ln (Total number of green patent applications + 1)
Independent Variable	Manufacturing Enterprise ESG Rating	ESG	Score corresponding to the ESG rating
Mediating Variables	Financing Constraint	SA	Absolute value of the SA index SA = -0.737*Size* + *0.043*Size - 0.040*Age
	Capital Market Attention	Att	Ln (Analyst attention + 1)
Control Variables	Firm Size	Size	Ln (Total assets + 1)
	Return on Equity	ROE	Net profit / Shareholders' equity
	Asset-Liability Ratio	Lev	Total liabilities / Total assets
	Firm Growth	Growth	(Current year operating income / Previous year operating income) - 1
	Fixed Assets	Fixed	Net fixed assets / Total assets
	Firm Age	Firmage	Ln (Current year - Year of firm establishment + 1)
	Shareholding Ratio of Top Three Major Shareholders	Top3	Number of shares held by the top three major shareholders / Total shares

3.3 Sample Selection and Data Sources

As the research subject of this paper is manufacturing enterprises, all enterprises outside the manufacturing sector were excluded in the data processing. Moreover, based on the robustness of the selected indicators and the integrity of the panel data, this paper takes the listed companies on the Shanghai and Shenzhen A-share markets in China from 2013 to 2023 as the research objects. Referring to existing studies, to enhance the reliability of the data, the following treatments were made to the sample data: (1) Eliminate listed companies with abnormal trading status such as ST, *ST, and PT, as

well as those with missing data; (2) Conduct 1% and 99% winsorization on the variables. Finally, through screening and data matching, 12,648 unbalanced panel data of 2,814 manufacturing enterprises were obtained. All the data in this paper are from the ESG rating database of listed companies, the website of the Chinese government, the CSMAR database, etc.

Table 2. Regression results

Variables	(1) GI	(2) GI	(3) GI	(4) GI
ESG	0.00529***	0.00503***	0.00502***	0.00501***
	(4.10)	(3.86)	(3.85)	(3.84)
Size		0.0361**	0.0372**	0.0372**
		(2.47)	(2.50)	(2.51)
ROE		0.00788	0.0110	0.00821
		(0.14)	(0.19)	(0.14)
Lev		0.0231	0.0245	0.0245
		(0.42)	(0.45)	(0.45)
Growth			-0.00768	-0.00802
			(-0.64)	(-0.67)
Fixed			0.00877	0.00945
			(0.12)	(0.13)
Firmage			-0.0347	-0.0209
			(-0.32)	(-0.19)
Top3				0.000506
				(0.63)
Dual				-0.00218
				(-0.14)
_cons	-0.0208	-0.826**	-0.748*	-0.812*
	(-0.22)	(-2.53)	(-1.71)	(-1.81)

4 Regression Analysis

4.1 Benchmark Regression Analysis

Table 2 presents the benchmark regression results of using the fixed effects model to test the impact of ESG of manufacturing enterprises on green innovation. Column (1) shows the regression results without including control variables, where the coefficient of GI is 0.00529 and is significant at the 1% level. As control variables are gradually added, both the coefficient and significance of GI change significantly. Column (4) shows the regression results including all control variables. The coefficient of GI remains significant, which proves that the ESG performance of manufacturing enterprises can directly promote the improvement of green innovation, thus verifying H1.

4.2 Endogeneity Test

Taking into account factors such as economic cycles, policy changes, or industry development, the ESG performance of manufacturing enterprises may have a lagging effect on green innovation. This paper introduces the lagged one period (L. ESG) of the ESG performance of manufacturing enterprises as a new explanatory variable for regression analysis (see Table 3 column (1)). Firstly, the ESG lagged by one period is correlated with the current ESG; secondly, the ESG lagged by one period is not related to the current disturbance term. The results show that the coefficient of L. ESG is 0.0058, and it is significant at the 1% level. Moreover, this paper uses the 2sls method for testing, and Table 4 columns (2) and (3) indicate that the results of the first and second stages of 2sls are both significant at the 1% level.

Table 3. Endogeneity test

	(1)	(2)	(3)
	L.GI	2SLS ESG (1st stage)	2SLS GI (2nd stage)
L.ESG	0.0058***	0.0248***	
	(3.68)	(13.03)	
ESG			0.0376***
			(13.00)
_cons	-1.418**	-5.663***	-6.145***
	(-2.19)	(-26.00)	(-25.76)
Controls	control	control	control
Firm	control	control	control
Year	control	control	control
N	8080	8564	8564
R^2	0.794	0.151	0.147

4.3 Robustness Test

Change the time range: In 2020, China introduced the "carbon neutrality" policy. To exclude the influence of this policy, in Table 4 column (1), only the data before 2020 is retained in this paper. After changing the time range, the ESG coefficient is 0.04. The result is still significantly positive at the 5% level, which is basically consistent with the previous text.

Replace the core explanatory variable: Considering that there are other measurement methods for ESG performance that might affect the consistency of the test results, this paper uses the Bloomberg ESG score to measure the ESG performance of manufacturing enterprises in column (2) of Table 5. The test results in column (2) of Table 4 show that the coefficient of the Bloomberg ESG score is 0.007, and it is significant at the 1% level, which proves the robustness of the regression results of this paper.

Add industry fixed effects: In column (3) of Table 4, this paper takes into account the impact of common industry shocks and adds industry fixed effects. The ESG co-

efficient remains significant at the 1% level and is positive. This further proves the reliability of the regression results in this paper.

Table 4. Robustness test

	(1) GI	(2) GI	(3) GI
ESG	0.004**		0.005***
	(2.18)		(3.95)
Pengbo ESG		0.007***	
		(4.48)	
_cons	0.294	-0.327	-0.803*
	(0.45)	(-0.40)	(-1.77)
Controls	control	control	control
Firm	control	control	control
Year	control	control	control
Industry			control
N	6697	4620	12133
R^2	0.789	0.799	0.771

4.4 Mediation Effect Test

Financing constraint (SA): Table 5 Column (1) reports the test results of the mediating effect of financing constraint (SA) on the ESG performance and green innovation of manufacturing enterprises. The impact of SA on green innovation is significantly negative at the 1% level, at the same timel, the confidence interval in the bootstrap does not include 0, and the p-value in the Sobel test is less than 0.05, indicating that alleviating financing constraints can enhance the green innovation of enterprises, which is consistent with the previous analysis. Regarding the impact of financing constraint on green innovation, a large number of existing studies have verified this. Therefore, combining the empirical analysis results with relevant research reports, it has been confirmed that the ESG performance of manufacturing enterprises can enhance green innovation by reducing financing constraints, and H2 has been verified.

Attention in the capital market: Table 5 column (2) shows that the regression coefficient of the correlation between capital market attention and the ESG performance of manufacturing enterprises on green innovation is 0.001, which is significant at the 10% level, at the same timel, the confidence interval in the bootstrap does not include 0, and the p-value in the Sobel test is less than 0.05. It can be seen that although it is impossible to significantly increase green innovation by enhancing the attention of the capital market, it still provides preliminary evidence supporting the importance of capital market attention as a transmission channel. This suggests that the ESG performance of manufacturing enterprises may promote green innovation through mechanisms such as attracting investors' attention and improving financing channels. H3 has been confirmed.

Table 5. Mediation effect test

	(1) GI	(2) GI	Bootstrap	Sobel test
SA	-0.667*** (-6.76)		0.022~0.063	0.00003
Att		0.001* (1.82)	0.026~0.628	0.000000001
_cons	2.223*** (3.67)	-0.446 (-0.99)		
Controls	control	control		
Firm	control	control		
Year	control	control		
N	12143	12143		
R^2	0.771	0.771		

5 Heterogeneity Analysis

5.1 Heterogeneity of Property Rights Nature

Considering that manufacturing enterprises with different property rights have significant differences in their governance goals, resource acquisition channels and external constraints, this paper conducts group tests based on property rights. In Column (1) of Table 6, the regression coefficient of ESG performance on green innovation for state-owned manufacturing enterprises is 0.001, which fails to pass the statistical significance test; while in the non-state-owned manufacturing sample, the regression coefficient of ESG is 0.005 and is significant at the 1% level. Furthermore, in the interaction term test, the interaction coefficient was -0.002, and the P-value was less than 0.01. This result indicates that in non-state-owned enterprises, the ESG of the manufacturing sector has a greater impact on green innovation. The main reason is that state-owned manufacturing enterprises usually undertake policy-oriented green innovation tasks, and ESG practices are more about strengthening existing environmental protection responsibilities, with a relatively weak incremental marginal effect; while non-state-owned manufacturing enterprises face more direct market competition and resource acquisition constraints, and have more motivation to make breakthroughs in green transformation technologies.

5.2 Heterogeneity of Enterprise Pollution Levels

The pollution emission intensity varies significantly among different industries within the manufacturing sector. The pollution attributes directly affect the intensity of environmental regulations faced by enterprises and the core orientation of ESG practices, which may also alter the impact effect of ESG on green innovation. Therefore, the analysis is conducted by grouping based on whether the industries are heavy polluters. In Table 6 column (2), for the samples of heavy-polluting manufacturing industries, the

regression coefficient of ESG on green innovation is 0.0027, which is significant at the 10% level; for the samples of non-heavy-polluting manufacturing industries, although the ESG coefficient is also 0.0034, it fails to pass the statistical significance test. In the interaction term test, the interaction coefficient was 0.005, and the P-value was less than 0.01. This indicates that the promoting effect of ESG on green innovation is mainly manifested in heavy-polluting manufacturing enterprises. The root cause of this heterogeneity lies in the fact that heavy-polluting manufacturing industries are subject to stronger environmental regulations, and the environmental dimension practices in ESG (such as investment in clean production technologies and pollution reduction management) are highly bound with green innovation. The performance of ESG not only reduces compliance risks but also enables enterprises to obtain environmental subsidies and technical special support, thereby promoting green innovation. In contrast, the environmental regulatory pressure on non-heavy-polluting manufacturing industries is relatively weak, and the correlation between the motivation for green innovation and ESG practices is relatively low.

5.3 Regional Heterogeneity

There is a significant imbalance in the degree of marketization, policy support systems and industrial layout among different regions in our country. This will affect the resource allocation and transmission efficiency of ESG practices of manufacturing enterprises. Therefore, this paper conducts group tests based on the regions where the enterprises are located. Table 6 column (3) shows that the group results of manufacturing enterprises in different regions exhibit obvious regional differences: In the manufacturing sample in the western region, the regression coefficient of ESG on green innovation is 0.006, which is significant at the 10% level; in the manufacturing sample in the eastern region, the ESG coefficient is 0.005 and is significant at the 1% level; while in the manufacturing sample in the central region, the ESG coefficient is 0.003, which does not show statistical significance. This result indicates that the promoting effect of ESG on green innovation is most significant in the eastern region, slightly less significant in the western region but still effective, and also not significant in the central region. Because the marketization degree of manufacturing in the eastern region is relatively high, ESG signals can effectively match resources such as green venture capital, industry-university-research innovation platforms, etc., accelerating the transformation of green innovation; although the marketization level and innovation foundation in the western region are weaker than those in the eastern region, as an important barrier for ecological protection in our country, regional-level high-intensity green development support policies have been introduced, meanwhile the manufacturing in the western region is mainly dominated by high-energy-consuming and high-emission industries. ESG practice is the core path for enterprises to respond to regional policies and break through environmental constraints. The policy dividends have enabled ESG to still effectively drive green innovation, thus maintaining a significance level of 10%. However, the industrial structure of manufacturing in the central region is relatively traditional and the ESG supporting system (such as green

finance, innovation incubation platforms) is relatively weak, leading transmission path of ESG on green innovation has not been fully and smoothly established.

Table 6. Heterogeneity analysis

	(1)		(2)		(3)		
	state-owned	Not state-owned	heavy pollution	Not heavy pollution	West	East	mid-land
ESG	0.001	0.005***	0.0027*	0.0033	0.006*	0.005***	0.003
	(0.51)	(3.36)	(1.80)	(0.78)	(1.67)	(3.34)	(1.08)
_cons	3.534***	-2.936***	1.126*	2.417	3.061**	-1.797***	1.633
	(3.42)	(-5.65)	(1.85)	(1.43)	(2.13)	(-3.36)	(1.48)
Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	3136	8947	5255	889	1450	8601	2032
R^2	0.806	0.750	0.665	0.597	0.678	0.782	0.778

6 Conclusion

This paper takes the listed manufacturing companies on the Shanghai and Shenzhen A-share markets from 2013 to 2023 as samples, and systematically explores the impact and mechanism of ESG on green innovation through an unbalanced panel data model. The research finds that the ESG performance of manufacturing enterprises has a significant positive promoting effect on green innovation. This conclusion remains valid after a series of endogeneity and robustness tests, including lagged one-period regression, 2SLS instrumental variable test, and replacement of core explanatory variables. The mediation effect test shows that ESG can empower green innovation through two paths: one is to alleviate financing constraints by obtaining green credit and environmental subsidies through enhanced information transparency and strengthened legitimacy; the other is to increase the attention of the capital market, attracting analysts' tracking and institutional investors' attention, and promoting green innovation through external supervision and optimized capital supply. Moreover, the mediating effect of financing constraints is a prominent factor. The heterogeneity analysis reveals that this promoting effect shows significant contextual differences, being more pronounced in non-state-owned enterprises, heavily polluting enterprises, and the eastern region.

Based on the above conclusions, this paper proposes the following suggestions: First, efforts should be made to ease the difficulty for non-state-owned manufacturing enterprises in obtaining green loans. This can be achieved by establishing a differentiated credit granting mechanism based on ESG performance, lowering the threshold for green loans, providing fiscal subsidies or risk compensation, etc., effectively alleviating their financing constraints, thereby stimulating the vitality of non-state-owned enterprises in green innovation. Second, for heavily polluting manufacturing industries, mandatory ESG disclosure policies should be implemented and linked with green

finance. By linking credit interest rates, green special subsidies with the environmental performance and green innovation output of enterprises, external constraints and incentives can be strengthened, forcing them to undergo substantive green innovation transformation. Third, the analyst coverage mechanism for manufacturing enterprises in the central region should be strengthened. Securities firms and research institutions should be encouraged to establish specialized research teams for the central region to track and rate enterprises with excellent ESG performance. By leveraging the information mining and external supervision functions of analysts, the transparency and market attention of enterprises in the central region can be enhanced, and the positive promoting effect of ESG on green innovation can be released.

Reference

1. Wang, H. L., Lian, X. Y., & Lin, D. M. (2016). An empirical analysis of the impact of green technology innovation efficiency on regional green growth performance. Science of Science and Management of S.& T., 37(6), 80–87.
2. Yuan, Y. J., & Chen, Z. (2019). Environmental regulation, green technology innovation and the transformation and upgrading of China's manufacturing industry. Studies in Science of Science, 37(10), 1902–1911.
3. Zhao, Q. N., & Li, H. (2024). Does ESG rating promote corporate green technology innovation: Micro-evidence from Chinese listed companies. South China Economy, (2), 116–135.
4. Li, J. L., Yang, Z., & Chen, J. (2024). How does ESG performance enable corporate green technology innovation: Micro-evidence from Chinese listed companies. Journal of Industrial Engineering and Engineering Management, 38(5), 1–17.
5. Yan, B., Cheng, M., & Wang, N. H. (2024). ESG green spillover, supply chain transmission and corporate green innovation. Economic Research Journal, 59(7), 72–91.
6. Dai, X., & Yang, S. Z. (2022). Digital empowerment, sources of digital input and manufacturing green transformation. China Industrial Economics, (9), 83–101.
7. Wang, S., & Jiang, S. (2024). The impact and mechanism of ESG performance on corporate green technology innovation. Research on Financial and Economic Issues, (4), 67–74+80.
8. He, J. J., & Tian, X. (2013). The dark side of analyst coverage: The case of innovation. Journal of Financial Economics, 109(3), 856–878.
9. Pástor, L., Stambaugh, R. F., & Taylor, L. A. (2021). Sustainable investing in equilibrium. Journal of Financial Economics, 142(2), 550–571.
10. Xu, Y. F. (2023). Media attention and corporate green investment: Reputation management or performance management. Communication of Finance and Accounting, (5), 48–52.
11. Porter, M. E., & van der Linde, C. (1995). Green and competitive: Ending the stalemate. Harvard Business Review, 73(5), 120–134.
12. Jiang, T. (2022). Mediating effects and moderating effects in causal inference research. China Industrial Economics, (5).
13. Li, Q. Y., & Xiao, Z. H. (2020). Heterogeneous environmental regulation tools and corporate green innovation incentives: Evidence from green patents of listed companies. Economic Research Journal, 55(9), 192–208.
14. Li, S. H., & Zheng, S. L. (2022). Does the implementation of ESG inhibit corporate growth?. Economic Issues, (12).

15. Hadlock, C. J., & Pierce, J. R. (2010). New evidence on measuring financial constraints: Moving beyond the KZ index. Review of Financial Studies, 23(5), 1909–1940.
16. Liu, W. Q., Li, J. Y., Zhou, J., et al. (2025). Does digital transformation enhance corporate economic and social value: Theoretical deduction and empirical test. Chinese Journal of Management Science, (5), 138–149.
17. Zeng, C. H., & Li, Y. Y. (2024). ESG biao xian ru he ying xiang gong si xian jin chi you? Jin Rong Li Li Yu Shi Jian, (3), 72-81.