

A Study on the Impact of ESG Performance on Corporate Green Innovation—An Analysis of Boundary Effects Based on Ownership Structure and Firm Size

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Abstract. In light of China's "Dual Carbon" goals and the continuous progress of the green economic revolution, many enterprises need to build a green competitive advantage urgently; therefore, this study takes A-share listed companies on the Shanghai and Shenzhen Stock Exchanges from 2009 to 2024 as the research subjects. Empirically examine the impact of corporate ESG performance on corporate green innovation Based on the above results, ESG performance is positively correlated with corporate green innovation. Further analysis shows that the moderating effects of firm size and ownership structure are not the same; a large enterprise is more likely to receive promotion for green innovation due to ESG factors, and this positive association is stronger for state-owned enterprises than for private ones. Theoretically, this paper adds to the existing body of empirical research. In practice, it offers an empirical basis and a decision-making reference for enterprises to promote the continuous development of green technology research and development, drive green transformation through ESG, and achieve sustainable development, etc.

Keywords: ESG performance, corporate green innovation, sustainable development, corporate competitiveness

1. Introduction

1.1. Research background

In September 2020, China proposed the "Dual Carbon" development goals and, as a result, entered a period of all-round and deep-seated transformation for its economy and society. Given the "dual carbon" goals, it is now necessary for enterprises to promote all-encompassing green development and create their own green competitive advantages. At the same time, continuous development of green investment in the capital market has been boosting the flow of funds to environmentally friendly enterprises.

Green innovation has the dual positive externalities of technological innovation and ecological benefits, and can be used to promote the balanced development of the economy and environment by promoting coordinated development. Green innovation projects are relatively long-term R&D ventures that carry high uncertainty and, therefore, are less appealing to capital seeking quick and

stable profits [1]. ESG refers to a person's non-financial indicators of how environmentally friendly, socially responsible and well-governed a company is; therefore, these indices provide investors with more comprehensive information about the company than traditional financial indicators focused solely on profit. An ESG rating provides external constraints and incentives for the continued improvement in the implementation of environmental, social and corporate governance practices over time [2]. Therefore, in recent years, enterprises have begun to give more weight to ESG performance in terms of capital allocation and sustainable development. Therefore, it can be seen that the company has high-end technology and is also concerned about environmental protection and building a good corporate image in the eyes of the public.

1.2. Research questions

Based on the above research, it has been shown that good ESG practices are positively associated with green innovation. Based on the above foundation, this paper explores the internal transmission paths through which ESG promotes green innovation and investigates its specific mechanisms of operation and limitations.

1.3. Research significance

Xu Zhiyong and others [3] believe that data assets are inherently opaque and thus difficult to quantify. By proactively disclosing information about their data assets in the ESG disclosure system, these companies can address the deficiency in traditional financial statements of lacking data elements and green investment information. Reduce the information gap between investors and financing institutions to promote green R&D investment in the company. Li Tiantian [4] believes that a company's good environmental performance is voluntarily in line with the requirements of environmental laws and reflects a sense of social responsibility. It helps the company continuously build moral capital from all sides, making shareholders, partners and other stakeholders more willing to provide various resources for the company and thus enabling the implementation of green technological innovation.

ESG compliance generally offers financial support for green research and development by reducing corporate financing risk, improves the company's image among the public, and raises the disclosure requirements for listed companies. The incremental theoretical contributions of this study include expanding and enriching the analytical system to cover the economic results of ESG as well as the main drivers of corporate eco-friendly innovation, expanding the research scope of how ESG management relates to green innovation, and strengthening the empirical evidence underlying these mechanisms. It hopes to provide practical ideas and decision-making references for enterprises to strengthen their ESG governance system, promote social responsibility in an all-weather way, advance green technology research and development steadily, and use ESG to drive green transformation and sustainable development.

2. Literature review and theoretical framework

2.1. Research on ESG performance

Wang Jiaqi and others [5] believe that the environmental aspect includes a company's environmental management, energy-use reduction and green-technology research and development; the social responsibility component covers philanthropy, product's ecological and labour-law compliance, and

corporate governance structures such as risk management and investor communication. The three will form an all-round system to assess the company's long-term operating capacity. At present, there are no unified standards for ESG disclosure by Chinese enterprises. Rating agencies vary in their selections of assessment factors, data sources, etc., and thus the ESG ratings issued by different agencies for the same company can differ significantly [6]. However, after the company publishes high-quality non-financial information on environmental protection, social responsibility and corporate governance in accordance with regulations, rich ESG data will help establish long-term cooperative relationships with stakeholders such as financial institutions and promote the accumulation of corporate social capital. Wang Jianxin [7] believes that, using the accumulated social capital of enterprises, credit allocation problems can be alleviated through bank relationships to obtain direct or indirect debt financing at a lower corporate financing cost. Construction of the ESG rating system has attracted the attention of the capital market to corporate sustainability and provided a standard set of evaluation indicators for investors. Liu Bo and others have studied in [8] that corporate managers are motivated to avoid a low ESG rating so as to prevent harm to their performance in the stock market. Therefore, ESG ratings can be regarded as a type of "soft regulation" that exerts legitimacy-based pressure; under this pressure, companies with poor ratings will actively improve their own performance through green innovation and other ways, and at the same time, will meet upstream compliance requirements and strengthen the oversight of the sustainability performance of their suppliers [9].

2.2. Research on corporate green innovation

The Goals of ecological innovation generally include developing green economic models and reducing pollution emissions in the process of industrialization [10]. Li Na [11] believes that green innovation can drive the development of enterprises at three levels: at the level of technology, breakthroughs in core technologies, such as low-carbon production processes and clean-energy substitution, need to be made to overcome emission-reduction bottlenecks; at the process level, green production processes are optimised, clean production and circular utilisation models are promoted, and resource consumption is reduced; and at the product level, green product lines, such as eco-friendly products and biodegradable packaging, need to be established to meet the green demands resulting from consumption upgrading precisely. Xu Shiyue [12] believes that measurement should focus on the results of a company's green innovation efforts and, therefore, needs to cover two aspects: green product innovation and green process innovation. The performance of green product innovation is shown by selecting low-pollution, low-energy-consumption and low-resource-consumption materials for environmentally friendly product upgrades; the performance of green process innovation is reflected in the optimisation and improvement of production processes, such as energy conservation, pollution prevention and waste recycling. Financing constraints are one of the main reasons why a company has not invested in green innovation. They directly affect a company's investment in innovation resources and, at the same time, change the company's decision-making logic for innovation, thus altering the level of innovation output. Funding constraints will likely restrict the progress of new-technology development for these companies. Financing constraints will increase the cost of capital for innovation investment and, therefore, make enterprises more risk-averse to high-risk and high-uncertainty technological innovation projects; thus, the scale of corporate innovation efforts will be limited [13]. However, some scholars have taken the opposite view and believe that under financing constraints, enterprises will be forced to make optimal investment decisions, strengthen the

management of innovation funds, and improve capital allocation efficiency to promote corporate innovation [14].

2.3. Theoretical foundation

In line with stakeholder theory, a company's economic results and social effects will affect all parties concerned to some extent. To safeguard their own interests, the concerned parties have taken various means to disrupt the company's business and policies. Yan Bing and others [15] believe that an increase in the ESG performance of a client company indicates that the company has paid more attention to and implemented more measures for environmental protection, social responsibility and corporate governance. It can be seen that the client will set a higher standard for operation and management, and is also demanding a higher ESG standard from the midstream enterprise in the supply chain. In light of the demands from customers for strengthened business cooperation and competition in the market, many midstream enterprises have begun to increase their own ESG performance in recent years.

3. Theoretical analysis and research hypotheses

3.1. ESG performance and corporate green innovation

Companies with good ESG performance are taking the initiative to set a time-bound goal for carbon peaking and carbon neutrality, increasing research and development and financial investment in energy-saving equipment, clean energy and recycling technologies for wastewater, exhaust gas and solid waste, and establishing an all-encompassing environmental management system. Tight internal environmental standards drive process optimisation and new-material R&D. At the same time, in accordance with the environmental policy and the requirements of a green-market system, many enterprises have begun releasing new low-carbon products and circular economy models by turning environmental pressure into a motivation for technological innovation. The contents of social responsibility include employee rights, supply chain management and public environmental and social activities. At the same time, the company will also offer good salaries, career development opportunities and incentives for research and development staff; hire professionals in environmental protection and new energy; and pass the green standard down to encourage upstream and downstream suppliers to adopt clean production. By promoting the concept of low-carbon development in the market and local communities, taking part in ecological restoration and environmental public welfare activities, and cultivating a green brand image, these companies have won the trust of the public and partners and expanded the application scenarios for green technologies. Good governance will be introduced to link the remuneration of top management to low-carbon innovation and environmental performance, prevent short-term profit-seeking behaviour from eroding long-term green R&D investment, and build an open internal control and risk management system. They proactively disclose green investments and innovation results to investors and regulatory authorities, are subject to oversight by the capital market and third parties, ensure effective top-down implementation of green strategies, and guarantee the sustainability and stability of innovation investments in environmental governance and social responsibility. Based on the above analysis, this paper proposes the following hypotheses:

H1: ESG performance significantly promotes corporate green innovation.

3.2. The moderating role of ownership structure

From a governance-oriented perspective, state-owned capital is subject to a stricter regulatory system and must be supervised by several government departments simultaneously, such as state-owned asset supervision and discipline inspection and supervision, auditing, finance, etc. Strict regulatory constraints will require enterprises to disclose more information in the public domain, reduce the scope of private data held by management, and thus need to implement higher-level, more extensive disclosure standards; as a result, more high-quality disclosed information will be released [16]. Based on the above analysis, this paper proposes the following hypothesis:

H2: Compared to non-state-owned enterprises, the promotional effect of SOEs' ESG performance on green innovation is stronger.

3.3. The moderating role of firm size

Xie Peihong and others [17] believe that proactively assuming social responsibility can win over the support of all parties to the firm, but there is a delay in the dissemination of information. Stakeholders need time to receive and process signals about corporate social responsibility, so the value-enhancing effect of corporate social performance has not yet been fully realised in the current period, and a lag has occurred. Large enterprises have more resources and economies of scale, so they are better able to implement green supply chain management. With a relatively larger amount of funds and resources, these companies are in a better position to carry out high-risk, large-scale projects such as green supply chain innovation. They will be able to carry out the green product commercialisation more efficiently and will have a stronger overall will to innovate in the ecological and environmental sector. In addition, due to their high public profile, large enterprises are subject to more scrutiny by the government and environmental groups, and are thus motivated to reduce their harm to the environment proactively [18]. Based on the above analysis, this paper puts forward the following hypothesis:

H3: The larger the enterprise, the stronger the promotional effect of ESG performance on green innovation.

4. Research design

4.1. Definitions of key variables

4.1.1. Dependent variable

The dependent variable in this paper is corporate green innovation (GI). As innovation activities are not easily quantified, most existing studies have used the three types of measurement indicators: inputs, outputs and performance. First, the input-dimension indicators are represented by R&D expenditure; second, the output-dimension indicators are centred on patent outcomes; and third, the performance-dimension indicators are represented by total factor productivity [11]. Among the three measurement methods, patent indicators are more suitable for this purpose: patents affect a company's operations from the time of application, and the data available at this stage is generally more timely and stable. Therefore, this study takes the number of corporate green patent applications as a proxy for green innovation.

4.1.2. Dependent variable

The explanatory variable in this paper is corporate ESG performance according to the Huazheng ESG rating system. Huazheng ESG rating uses big data technology to strengthen quantitative analysis and local adaptation, integrates mature international ESG frameworks, aligns with the actual situation of China's capital market, and establishes a three-tier indicator evaluation system. The Rating System has collected many types of traditional and non-traditional data to build an all-encompassing profile of disclosed information by listed banks, special reports on social responsibility and sustainable development, data released by regulatory platforms, and various news and public opinion materials. It will lower the grade following a negative occurrence, such as a fine from the government or a drop in media attention; otherwise, it will remain unchanged and be rated AAA. A High ESG Score Indicates Better Corporate ESG Performance.

4.1.3. Control variables

Based on the previous research, the following control variables that may affect a company's ESG performance have been included in the model of this paper: (1) Return on Assets (ROA), defined as the proportion of a company's net profit at the end of the year to its average total assets over a certain period; (2) Gross Profit Margin, which is the ratio of gross profit to operating revenue; and (3) Quick Ratio, defined as the ratio of quick assets to current liabilities.

4.1.4. Moderating variables

Two moderator variables in this study are included: firm ownership type (SOE) and firm size. The two kinds of ownership are state-owned and non-state-owned enterprises, and firm size is taken as the natural logarithm of total assets at the end of the year. The addition of these moderator variables can explore whether the effect differs under various circumstances of firm ownership and size.

4.2. Model specification

According to the variable selection results in the above steps, the econometric model is as follows:

$$GI_{it} = \alpha_0 + \alpha_1 ESG_{it} + \sum_{i=1}^n \beta_i Controls_{i,it} + \mu_i + \gamma_t + \varepsilon_{it}$$

Here, " GI_{it} " serves as the dependent variable, representing a firm's " i " in " t "; " ESG_{it} " serves as the independent variable, representing a firm's " i " in " t "; the parameter " α_1 " denotes the effect of a firm's ESG performance on green innovation. " $Controls$ " represents a set of control variables, with " β_i " and " γ_t " representing firm-level and year-level control effects, respectively; " ε_{it} " denotes the random error term in the model.

5. Empirical analysis

5.1. Descriptive statistics

The first independent variable is Green Development Level (Green), and its mean is 6.020 with a standard deviation of 19.024. There is a large gap in green investment and green development among the sample firms; a significant number of firms have very low levels of green development, and only a few firms have a green scale that is far ahead of the rest. The mean of the dependent variable ESG comprehensive performance is 4.141, the standard deviation is 1.090, and the range of scores is 1-9. Generally speaking, it is in the upper-middle range, and the ESG performance of the companies is relatively uniform. Financial control variables: The mean Return on Assets (ROA) is 0.034, and the standard deviation is 0.065; there is a negative extreme value of -0.556, indicating that some enterprises are operating at a loss; the mean Gross Profit Margin is 0.289, and its range of values is from negative to 0.871, showing that the profitability of the enterprises varies significantly; The mean quick ratio (Quick) is 2.117, and the standard deviation is 2.623; thus, the firms' ability to pay off short-term debts is highly unevenly distributed. The number of observations for all variables was still around 47,491, and only two fewer than that were available for gross profit margin. The sample size is reasonable, and the distribution characteristics of the financial and ESG indicators are in line with the general features of domestic A-share listed companies; thus, the sample is representative.

Table 1. Descriptive statistics

Variable	Obs	Mean	Std.dev.	Min	Max
Green	47,491	6.020	19.024	0	203
esg	47,491	4.141	1.090	1	9
ROA	47,491	0.034	0.065	-0.556	0.222
Gross Profit	47,489	0.289	0.179	-0.065	0.871
Quick	47,491	2.117	2.623	0.149	33.842

5.2. Analysis of empirical results

Column (1) of Table 2 shows that, without controlling for other variables, the estimated coefficient of ESG is positively correlated with the level of green development at the 1% significance level; thus, a higher ESG performance is associated with a higher level of green development. Column (2) lists all the financial control variables; after adding them, the main effect hypothesis was still supported, and good ESG performance consistently promoted green innovation in these enterprises. Columns (3) and (4) additionally examine for moderation effects. Thus, it can be seen that the size of the enterprise positively moderates the effect of ESG performance on green development; that is, large enterprises benefit more from high ESG scores in achieving green development goals, and thus a separate effect for different sizes of enterprises has been verified. Column (4) supports the hypothesis of ownership moderation and provides theoretical support for it; that is, due to their reliance on policy resources and relatively strong environmental and social responsibility constraints, improvements in ESG performance have a stronger positive impact on green development for state-owned enterprises than for private enterprises.

Table 2. Baseline regression results

	Green	Green	Green	Green
esg	2.561*** (0.079)	2.809*** (0.081)	-41.088*** (1.144)	1.881*** (0.100)
esg*Size			1.885*** (0.051)	
esg*SOE				2.278*** (0.164)
Control variables	No	Yes	Yes	Yes
N	47491	47489	47,489	47489
R2	0.022	0.039	0.196	0.048

5.3. Robustness tests

Table 3. Robustness tests

	Green1	Green1
esg	0.141*** (0.004)	0.165*** (0.004)
esg*Size		
ESG*SOE		
Control variables	No	Yes
N	47491	47489
R2	0.022	0.060

Robustness test: Replace the original green development indicator 'Green' with an alternative indicator 'Green1' and conduct this study again. In the first column, without adding financial control variables, the coefficient of the main explanatory variable ESG is still positively significant at the 1% level; in the second column, after adding all the control variables—ROA, gross profit margin and quick ratio—ESG remains positively significant at the 1% level, and both the significance and the direction of the effect are in line with those in the baseline regression. After replacing the green development index, the main conclusion that ESG improves a company's level of green development has not changed, and the results of the baseline regression in this study are robust. The primary effect relationship is valid and not due to a random change in the measurement method of a single variable.

6. Conclusions and recommendations

6.1. Research conclusions

Empirically, it has been shown that good ESG performance by enterprises promotes green innovation and development to a certain extent, and these two are positively correlated; thus,

Hypothesis H1 has been verified. At the level of heterogeneity, both firm size and ownership structure serve as positive moderators: larger firms have a more significant supportive impact of ESG on green innovation (Hypothesis H3), and state-owned enterprises, with both policy constraints and resource advantages, exhibit an even stronger promotion effect of ESG for green innovation compared to private enterprises (Hypothesis H2). Therefore, enterprises should integrate ESG into their green innovation strategies, continuously strengthen the environmental governance system, standardize ESG disclosure, increase investment in green research and development, and leverage the advantages of high ESG performance to provide robust support for green innovation and achieve continuous progress. At the same time, regulatory authorities should issue uniform ESG disclosure rules, introduce targeted policies to motivate enterprises to engage in green innovation, and guide capital markets to allocate resources in a way that supports the stable progress of green transformation for enterprises through ESG efforts.

6.2. Limitations and future directions

Only the general level of the company's green development is measured in this study, and the substantial and strategic types of green innovation are not distinguished; therefore, the different driving effects of ESG on green innovation based on various motivations cannot be identified. At the same time, only two moderating variables are considered—firm size and ownership structure—and key external and internal factors, such as industry attributes, the strength of regional environmental regulations, and the degree of digitalisation, are not included in the scope of the study. Future research may divide the types of green innovation for comparison, extend tests of heterogeneity in industry and regional regulations, and introduce digital transformation as a mediating or moderating variable. It will be possible to explore the multiple pathways of transmission for ESG factors in green development more deeply, thereby expanding the theoretical and empirical foundation of their internal workings.

References

- [1] Lian, Y. H., Teng, A. Z., & Li, J. (2026). Consistency of ESG performance between banks and enterprises and corporate green innovation. *Contemporary Finance & Economics*.
- [2] Yan, J. Z., Luo, D. Q., Li, Z. F., & et al. (2026). Research on the impact of ESG uncertainty and noise on sustainable investment. *Systems Engineering Theory and Practice*.
- [3] Xu, Z. Y., Liu, S. Y., Chen, Y., & et al. (2026). Research on the impact of data asset information disclosure on green technological innovation. *Science Research Management*.
- [4] Li, T. T. (2024). The green productivity effect of corporate ESG performance fulfillment: From the perspective of green technological innovation. *Scientific Decision-Making*, (5), 109–130.
- [5] Wang, J. Q., Lang, L. H., & Chu, T. T. (2026). ESG performance and corporate export behavior. *Statistics*.
- [6] Wang, J., & Yu, B. (2026). Corporate ESG rating divergence and executive opportunistic share reduction. *Journal of Guizhou University of Finance and Economics*, (3), 120–132.
- [7] Wang, J. X. (2023). ESG performance and corporate upgrading. *Journal of Financial Research*, (11), 132–152.
- [8] Liu, B., Lu, J. R., & Ju, T. (2023). Formalism or substantialism: Research on green innovation under soft market supervision of ESG rating. *Nankai Business Review*, 26(5), 16–28.
- [9] Yan, R. S., & Jiang, X. (2025). Customer firms' ESG ratings and supplier firms' green innovation. *Systems Engineering Theory and Practice*, 45(4), 1168–1188.
- [10] Yang, H. L., & Liu, F. M. (2026). Research on corporate green innovation paths based on customers' green pressure: Evidence from 137 technology-based SMEs. *Dongyue Tribune*, 47(5), 124–137.
- [11] Li, N. (2026). Logistics standardization policy and corporate green innovation: Effects, paths and
- [12] Xu, S. Y. (2025). Research on the impact of supply chain digital transformation of Zoomlion on green innovation performance (Master's thesis). *Xiangtan University*.

- [13] Ji, L. Y. (2018). The impact of technological innovation on the upgrading of China's manufacturing industrial structure: Based on the moderating effect of financing constraints. *Technology Economics*, 37(11), 30–36.
- [14] Ye, C. H. (2021). Financing constraints, government subsidies and corporate green innovation. *Statistics & Decision*, 37(21), 184–188.
- [15] 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.
- [16] Wang, X. Y., Wang, T., & Feng, Q. G. (2026). Can state-owned capital participation mitigate information frictions in the capital market? Evidence from the perspective of ESG rating divergence. *Foreign Economics & Management*.
- [17] Xie, P. H., Yu, J. X., & Zou, J. Y. (2026). Research on the impact of corporate ESG performance on corporate value: An empirical analysis based on A-share listed companies in Shanghai and Shenzhen. *Journal of Shanghai University of International Business and Economics*.
- [18] Liu, S. M. (2025). Paths of environmental regulation driving green supply chain management: Chain mediating effect of entrepreneurship and circular-oriented resource commitment and moderating effect of firm size. *Science and Technology Management Research*, 45(24), 213–220.