
The Impact of ESG Performance on Corporate Green Technology Innovation

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ABSTRACT: *With the advancement of socialist modernization, the state requires the entire Party and society to firmly establish the concept of ecological civilization, supporting high-quality economic development through a premium ecological environment. Enterprises must reevaluate their long-term development strategies and continuously promote green technology innovation to adapt to dynamic changes in policy orientation and market demands. This study employs a sample of China's A-share listed companies from 2013 to 2023 to construct a mixed-effects regression model, exploring the impact of ESG performance on corporate green technology innovation. The findings reveal: (1) Strong ESG performance significantly enhances corporate green technology innovation; (2) Internal control plays a mediating role in the relationship between ESG performance and green technology innovation. Based on these conclusions, recommendations are proposed from governmental and corporate perspectives: Governments should improve ESG information disclosure mechanisms, implement moderate policy incentives to support green technology innovation, and guide investor participation in ESG practices to create a favorable investment environment. Enterprises should establish ESG-oriented philosophies, increase ESG-related investments, and strengthen internal controls to amplify the promoting effect of ESG performance on green technology innovation.*

KEYWORDS: *Enterprise Green Technology Innovation, ESG Performance, Internal Control*

I. INTRODUCTION

In the new era, the "dual carbon" strategy is spawning new quality productive forces characterized by green and low-carbon features, accelerating the lead of a new round of industrial revolution, and promoting the green transformation of the economy and society. President Xi Jinping pointed out that achieving the goals of carbon peak and carbon neutrality is essentially the implementation of the new development concept of innovation, coordination, green, openness, and sharing, as well as an inevitable choice in building a new development pattern of domestic and international dual circulation, which is a deep-seated requirement for China's high-quality economic development. During the "14th Five-Year Plan" period, the realization of this goal faces an important period of opportunities and challenges. Various regions and government departments should firmly adhere to the path of ecological civilization and green development, systematically adjust industrial structures, strengthen pollution control, protect the ecological environment, and actively respond to climate change. By synergistically promoting the multiple goals of carbon reduction, pollution reduction, green expansion, and economic growth,

we will continuously push green and low-carbon development to a new level. Against this background, ESG (Environmental, Social, and Governance) performance has gradually attracted widespread attention, becoming an important tool for promoting the implementation of the "dual carbon" strategy at the macro level, and being regarded as a key indicator for measuring corporate sustainable development and social responsibility fulfillment at the micro level. ESG performance comprehensively evaluates the sustainability of an enterprise through three dimensions: environment, social responsibility, and corporate governance, reflecting a more environmentally friendly development path, a more socially responsible corporate image, and a more perfect corporate governance system. This concept is highly consistent with many major development goals currently pursued by China, providing important support for achieving high-quality economic development. In recent years, corporate green technology innovation has gradually become the focus of academic attention, but there is no very accurate conclusion on how ESG performance affects corporate green technology innovation. Existing studies mostly focus on external factors such as government subsidies, tax incentives, or economic incentives, and pay less attention to the role of internal corporate governance mechanisms. Therefore, studying the impact of ESG performance on corporate green technology innovation and its mechanism is conducive to encouraging enterprises to carry out green technology innovation activities, promoting enterprises to better follow the concept of sustainable development, changing the national economic development mode, and promoting the vigorous development of the green economy.

As an unconventional investment indicator and corporate evaluation standard, ESG performance mainly includes three elements: Environment (E), Social (S), and Governance (G). Compared to traditional financial indices and business performance evaluations, ESG performance focuses on revealing dimensions of corporate performance that are important but not directly reflected by financial data. ESG performance is a comprehensive indicator that integrates a company's environmental, social, and governance performance into the evaluation system, serving as an important standard for measuring the level of sustainable development of a company. The universality, quantifiability, comprehensiveness, and systematicness of ESG performance make it a widely recognized and adopted evaluation method across industries internationally, as well as a consideration standard when evaluating investment objects. For enterprises, adopting ESG principles means adopting a more advanced, reasonable, globally-minded, and comprehensive corporate governance approach.

Currently, academic research on ESG performance mainly focuses on its effects. Yuan Zeming (2023) believes that enterprises actively promoting environmental governance and social responsibility are more likely to attract government attention, become the preferred choice for government procurement, and may obtain corresponding financial subsidies or tax incentives to alleviate financing constraints, thereby enhancing corporate value [1]. Li Jinglin et al. (2021), based on data from Chinese A-share listed companies, found that ESG performance significantly promoted corporate innovation investment by alleviating financing constraints and enhancing stakeholder trust [2]. Gao Jieying et al. (2021) further pointed out that enterprises

with outstanding ESG performance have an advantage in resource allocation efficiency, especially in the fulfillment of environmental responsibilities, transmitting positive signals of sustainable development through the application and authorization of green technology patents [3]. Wang Bo and Yang Maojia (2022) suggested that ESG performance significantly increases a company's market value by reducing financing costs and attracting market attention [4]. In addition, Long Ziwu and Zhang Xiaofei (2023) found through analysis that the impact of ESG performance exhibits industry heterogeneity, with heavily polluting industries and high-tech industries responding more significantly to ESG pressures [5].

Currently, academic research on corporate green technology innovation primarily focuses on its influencing factors. Scholars have mainly explored the impact of environmental regulation, green credit policies, and internal/external environments on corporate green technology innovation.

As the core path to achieving the "dual carbon" goals, the driving factors and impact mechanisms of green technology innovation have garnered much attention. Environmental regulation is considered a key external driving force. Guo Jin (2019), based on Chinese manufacturing data, verified that environmental regulation significantly improves the output efficiency of green patents by forcing enterprises to optimize production

processes. Moreover, the role of financial support in green technology innovation cannot be ignored [6]. Xiong Ling et al. (2023) showed that digital finance provides stable financial guarantees for green R&D by alleviating financing constraints; especially in the industrial sector, the synergistic effect of finance and the environment promotes biased green technology innovation [7]. Corporate micro-level governance mechanisms have also been proven to have a significant impact on green innovation. Lin Binghong and Li Bingxiang (2022) found that the perfection of the internal control system can reduce agency risks in R&D activities and enhance the sustainability of green technology innovation by standardizing resource allocation processes [8]. Yue Mengting et al. (2021) conducted a regional heterogeneity analysis, further revealing that due to policy support and economic agglomeration effects, the efficiency of green technology innovation in the eastern region is significantly higher than that in the central and western regions [9]. Green credit policies and internal/external environments are also focal points of scholars' concerns regarding corporate green technology innovation. Many scholars have studied the changes in corporate green technology innovation before and after the implementation of the "Green Credit Guidelines". Wang Xin and Wang Ying (2021) found that after the implementation of the "Guidelines", compared with non-green-credit-restricted industries, the green innovation vitality of green-credit-restricted industries significantly increased, and the quantity of green innovation greatly increased, but the quality of green innovation did not improve significantly [10]. Yu Bo (2021) found that after the introduction of the "Guidelines", compared with enterprises in other industries, the technological innovation output of heavily polluting enterprises significantly decreased. Many scholars believe that the internal and external environments are also important factors affecting corporate green innovation [11].

Regarding the external environment, research conducted by Zhao Li and Zhang Ling (2020) concluded that media attention has a positive impact on green technology innovation investment, and when this impact works together with the level of marketization, it affects the output of green technology innovation [12]. From the perspective of the market environment, Kong Lingwen (2022) found that a company's innovation is related to the degree of market competition; when market competition is fierce, the motivation for companies to innovate is stronger, and the output of innovation results is also greater [13]. Wang Yonggui (2023) studied the impact of government subsidies on two different types of green innovation performance, finding that government subsidies have a positive effect on strategic green innovation, but exhibit an "inverted U-shaped" relationship with substantive green innovation. Further research found that environmental regulation and managerial environmental attention both have a negative moderating effect on the relationship between government R&D subsidies and strategic green innovation performance, while having a positive moderating effect on the relationship between government R&D subsidies and substantive green innovation performance [14]. From the perspective of the internal environment, Zou Zhiyong (2019) conducted research from the characteristics of the top management team, arguing that executives' environmental awareness is positively correlated with corporate green innovation; that is, the stronger the executives' environmental awareness and social responsibility, the more likely they are to value green innovation strategies and carry out green innovation work [15]. Qi Liyun (2023) investigated the relationship between top management team heterogeneity and corporate green innovation, finding that the functional background heterogeneity of the top management team has a positive impact on green technology innovation [16]. Currently, there are relatively few studies on the impact of ESG performance on corporate green technology innovation, and the mechanism by which ESG performance acts on corporate green technology innovation still needs to be verified. Based on this, this paper takes China's A-share listed companies from 2013 to 2023 as the research object to empirically analyze the impact of ESG performance on corporate green technology innovation and the moderating mechanism of internal control on the relationship between the two.

Exploring how ESG performance affects corporate green technology innovation has become one of the common focuses of academia and practice. Research on the impact of ESG performance on corporate green technology innovation helps to achieve the "dual carbon goals", namely carbon peak and carbon neutrality. The research results provide theoretical and practical guidance for enterprises and governments in promoting green technology innovation and sustainable development. First, expanding the research on the relationship between ESG performance and corporate green technology innovation provides a path reference for enterprises to optimize

ESG practices. Second, deepening the theory of the mediating role of internal control. Traditional research regards internal control as a risk management tool, paying less attention to its dynamic role in strategic transformation. Third, helping policymakers improve incentive and regulatory mechanisms.

II. METHODS AND DATA

2.1 Research Methods

In terms of research methods, this study uses a combination of literature research, theoretical analysis, and empirical testing. First, through literature research, we systematically review the research results on ESG performance, corporate green technology innovation, and internal control at home and abroad, summarize the shortcomings of existing research, and provide a theoretical foundation and research ideas for this study. Second, using theoretical analysis, based on stakeholder theory, resource-based theory, and agency theory, we construct a theoretical framework of the relationship between ESG performance and corporate green technology innovation, and propose corresponding research hypotheses. Finally, using empirical testing, we select Chinese A-share listed companies as the research sample and apply statistical methods such as multiple regression analysis to verify the research hypotheses and analyze the impact of ESG performance on corporate green technology innovation and its mechanism. Through the comprehensive application of the above research methods, this paper aims to provide theoretical support and practical guidance for corporate sustainable development.

2.2 Sample Selection and Data Sources

This paper takes China's A-share listed companies from 2013 to 2023 as the research sample. During the sample selection process, companies in the financial industry and ST, *ST companies were excluded, and samples with missing data for variables were also removed, ultimately obtaining 21,174 valid sample observations. In terms of data sources, the measurement standard for ESG performance information disclosure adopts the Huazheng ESG rating scores; internal control data is based on Dibo internal control rating scores; data related to corporate green technology innovation comes from the Chinese Research Data Services (CNRDS) platform; and control variable data are all taken from the CSMAR database. To reduce the potential interference of extreme values on the research results, continuous variables were winsorized at the 1% level.

III. THEORETICAL ANALYSIS AND RESEARCH HYPOTHESES

3.1 ESG Performance and Corporate Green Technology Innovation

According to stakeholder theory, enterprises are situated within a social interaction network, and their main mission is to coordinate and optimize the well-being of all stakeholders, aiming to balance social justice and economic efficiency. As an innovative practice of enterprises, green technology innovation is characterized by high risk and high cost, requiring enterprises to invest massive resources for revolution. Excellent ESG performance can consolidate the trust bond between enterprise management and various stakeholders, thereby guiding enterprises to increase investment in environmental protection, social benefit enhancement, and employee welfare improvement to win broad support. Specifically, encouraging employees to participate in corporate green technology innovation can stimulate their enthusiasm, thereby attracting government and public cooperation and assistance in terms of technology and funding, ultimately leading to shared success among multiple entities.

Signaling theory suggests that ESG performance can transmit a company's performance in ESG aspects to the external market, which traditional financial indicators fail to convey, acting as a signal of a company's green and sustainable development. By disclosing a company's performance in terms of environment, social responsibility, and corporate governance, ESG performance increases corporate information transparency from all dimensions, provides external stakeholders with more information about the company's operating status, thereby reducing information asymmetry, alleviating the financing constraints faced by corporate green

technology innovation, and providing it with abundant resources. The ESG reports issued by enterprises comprehensively reveal their non-financial performance, significantly bridging the information gap with various stakeholders. This measure not only helps shape the positive image of a responsible enterprise and enhances corporate reputation, but also conveys positive signals to the financial market, attracting more capital investment in green technology innovation R&D. In addition, by disclosing ESG performance, the transparency of corporate internal governance structures is enhanced, thereby establishing a potential supervision framework by stakeholders over management, effectively reducing agency costs. This mechanism prevents management from neglecting green technology innovation investment due to pursuing individual interests or short-term performance, ensuring the continuous and uninterrupted progress of corporate green technology innovation activities.

Based on the analytical framework of principal-agent theory, the ESG rating system presents unique institutional value in optimizing corporate governance efficiency. By constructing a standardized non-financial information disclosure paradigm, this mechanism significantly alleviates the information gap between business owners and managers. Specifically, the improvement of ESG information disclosure quality not only effectively compresses the agent's space for information manipulation, but more importantly, through the transmission of quantitative evaluation indicators, it reconstructs the supervision and incentive mechanism of stakeholders. This institutional arrangement enables external investors to identify management's opportunistic tendencies at a lower marginal cost, thereby forming a checks-and-balances force against short-term profit-seeking behaviors. Based on this, this paper proposes hypothesis H1.

H1: Good ESG performance can promote corporate green technology innovation.

3.2 The Mediating Role of Internal Control

Based on the resource-based view and stakeholder theory, ESG performance exerts a transmission effect on corporate green technology innovation through the internal control system. The first transmission path is manifested as a resource integration mechanism: ESG practices optimize ecological resource allocation through environmental management, strengthen stakeholder collaboration through social responsibility, and enhance scientific decision-making through governance efficiency. High-quality internal control, as an institutional guarantee, can systematically screen the green knowledge capital accumulated from ESG performance (such as environmental technology patents) and orientally allocate it to R&D activities through budget control and risk management mechanisms. The second transmission path stems from an information governance mechanism: ESG performance transmits credible signals to the market through the information disclosure system of internal control, reducing external financing constraints for green technology innovation R&D. Simultaneously, internal control reduces environmental compliance risks through compliance reviews, enhancing the company's strategic focus on long-term green technology innovation investment.

In addition, dynamic capability theory further explains the relationship among the three: The various dimensions of ESG performance influence internal control efficacy through differentiated paths—environmental responsibility forces enterprises to establish environmental risk early warning modules, social responsibility promotes supply chain moral audit mechanisms, and governance efficiency perfects the board of directors' supervisory functions on green innovation. These institutional improvements collectively constitute the dynamic capability foundation for enterprises to identify, absorb, and transform green technology opportunities. The localized Huazheng ESG rating system, deeply embedded in the Chinese policy context (such as the "dual carbon" goal), has evaluation results that better reflect the co-evolutionary characteristics of internal control systems and corporate green technology innovation incentives. Based on this, hypothesis H2 is proposed.

H2: Internal control plays a mediating role in the relationship between ESG performance and corporate green technology innovation.

IV. RESEARCH DESIGN

4.1 Variable Definitions

Core Explanatory Variable: Currently, major corporate ESG rating systems include Huazheng, Bloomberg, Refinitiv, SynTao Green Finance, and FTSE Russell. Comparing these systems, the localized rating agency Huazheng ESG evaluation system shows significant advantages. Its coverage is broader, effectively including Chinese enterprises of different scales and industries. Furthermore, its indicator framework is more systematic, constructing a multi-level evaluation standard comprising 3 first-level dimensions, 28 second-level indicators, and over a hundred specific observation points. The Huazheng methodology fully integrates China's policy orientation and market characteristics, better fitting the actual operating characteristics of Chinese enterprises. Based on these comparative advantages, this paper selects the Huazheng ESG rating indicator as the core explanatory variable, using the comprehensive score to measure ESG performance.

Explained Variable: Referring to previous scholars like Li Jinglin et al. (2021), this paper uses the natural logarithm of the number of green patent applications in the year plus 1 to measure corporate green technology innovation (GI), avoiding the influence of 0 values and heteroscedasticity. The total green patent applications are the sum of green invention patents and green utility model patents applied for in the year.

Mediating Variable: The mediating variable is internal control (IC), measured using the Dibo internal control rating score divided by 1000.

Control Variables: Referring to Sun Xinxian et al. (2024), Firm Size (Size), Intangible Asset Ratio (Ibl), Tobin's Q (Tbq), and Firm Age (Fage) are selected as control variables.

Table 1 defines the primary variables.

Table 1: Variable Measurement Description

Variable Type	Variable Name	Symbol	Variable Definition
Explanatory Variable	ESG Performance	ESG	Huazheng ESG Rating Score
Explained Variable	Corporate Green Technology Innovation	GI	Ln(Number of green patent applications + 1)
Mediating Variable	Internal Control	IC	Dibo Internal Control Index / 1000
Control Variables	Firm Size	Size	Ln(Annual total assets)
	Intangible Asset Ratio	Ibl	Net intangible assets / Total assets
Variable Type	Variable Name	Symbol	Variable Definition
	Tobin's Q	Tbq	Market value / Total assets

	Firm Age	Fage	Ln(Current year - Establishment year + 1)
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4.2 Model Specification

To verify hypothesis H1, this paper constructs model (1):

$$GI_{i,t} = \alpha_0 + \alpha_1 ESG_{i,t} + \sum \alpha_j Controls_{i,t} + \varepsilon_{i,t} \quad (1)$$

Where GI is the explained variable, representing the green technology innovation level of enterprise i in year t. ESG is the explanatory variable. Controls are the control variables, ε is the error term, α_0 is the constant term, and α are the coefficients to be estimated.

To verify H2, based on model (1), models (2) and (3) are constructed:

$$IC_{i,t} = \beta_0 + \beta_1 ESG_{i,t} + \sum \beta_j Controls_{i,t} + \varepsilon_{i,t} \quad (2)$$

$$GI_{i,t} = \gamma_0 + \gamma_1 ESG_{i,t} + \gamma_2 IC_{i,t} + \sum \gamma_j Controls_{i,t} + \varepsilon_{i,t} \quad (3)$$

Where IC represents the internal control level. The other variable definitions are consistent with model (1).

V. EMPIRICAL TEST AND ANALYSIS

5.1 Descriptive Statistics

Table 2 presents the descriptive statistics. The mean of GI is 0.873, with a standard deviation of 1.181, and the median is 0, indicating that the overall green technology innovation is relatively low. ESG has a mean of 73.630, indicating an upper-middle level. IC has a minimum of 0 and a maximum of 0.941, indicating obvious differences in internal control among listed companies.

Table 2: Descriptive Statistics Analysis Results

Variable	Observations	Mean	Std. Dev.	Min	Median	Max
GI	21174	0.873	1.181	0	0	7.223
ESG	21174	73.630	4.947	36.620	73.820	92.930
IC	21174	0.634	0.123	0	0.656	0.941
Size	21174	22.300	1.392	17.800	22.040	28.700
Ibl	21174	0.047	0.064	0	0.031	0.864
Tbq	21174	2.128	2.108	0	1.649	102.4
Fage	21174	2.981	0.302	1.386	2.996	4.190

5.2 Correlation Analysis

Table 3 shows the Pearson correlation coefficients. ESG is significantly positively correlated with GI at the 1% significance level, confirming hypothesis H1. Furthermore, Variance Inflation Factor (VIF) values are all below 1.12, ensuring no multicollinearity.

Table 3: Correlation Analysis Results

Variable	GI	ESG	Size	Ibl	Tbq	Fage
GI	1					
ESG	0.153***	1				
Size	0.431***	0.239***	1			
Ibl	0.059***	-0.024***	0.097***	1		
Tbq	-0.108***	-0.091***	-0.294***	-0.039***	1	
Fage	-0.004	-0.006	0.152***	0.007	-0.044***	1

5.3 Regression Analysis

5.3.1 ESG Performance and Corporate Green Technology Innovation

Table 4 presents the regression results. The coefficient of ESG in column (2) is 0.0123, significantly positive at the 1% level, supporting hypothesis H1.

5.3.2 The Mediating Effect of Internal Control

Column (3) shows ESG significantly improves IC. Column (4) shows after adding IC, the coefficient of ESG is 0.0116, remaining significantly positive at the 1% level, confirming the mediating role of internal control (hypothesis H2).

Table 4: Multiple Regression Analysis

Variable	(1) GI	(2) GI	(3) IC	(4) GI
ESG	0.0366***	0.0123***	0.0060***	0.0116***
IC				0.1205*
Size		0.3683***	0.0106***	0.3670***
Ibl		0.3579***	-0.0200	0.3603***
Tbq		0.0125***	0.0022***	0.0123***

Fage		-0.2706***	-0.0314***	-0.2668***
_cons	-1.8213***	-7.4833***	0.0454**	-7.4888***
N	21174	21174	21174	21174
R ²	0.023	0.194	0.087	0.194

5.4 Robustness Test

Table 5 confirms robustness by replacing the explained variable with independent green inventions (GI2) and the explanatory variable with the Wind ESG Rating index (ESG2).

Table 5: Robustness Test Results

Variable	(1) GI2	(2) GI
ESG	0.013***	
ESG2		0.012***
Size	0.298***	0.368***
Ibl	0.003	0.358***
Tbq	0.019***	0.013***
Fage	-0.204***	-0.271***
_cons	-6.451***	-7.483***
N	21174	21174
R ²	0.182	0.194

VI.CONCLUSION

Taking China's A-share listed companies from 2013 to 2023 as the research object, the primary task of this study is to deeply analyze the driving effect of ESG performance on corporate green technology innovation activities through the implementation of multiple regression analysis; subsequently, a three-step mediation method is utilized to verify in detail the mediating effect of internal control in the relationship between the two. The results show:

First, good ESG performance can significantly improve the level of corporate green technology innovation. Good ESG performance can increase a company's sense of social responsibility and lead to more

funding being invested in green technology innovation. Companies typically allocate a portion of their profits to R&D and innovation projects. Good ESG performance not only optimizes the company's financial allocation but also prompts the company to gain more support from relevant stakeholders. It can attract more investors and consumers, increase the company's revenue and profits, and thereby enhance the company's investment in the field of green technology innovation.

Second, internal control plays a mediating role between ESG performance and corporate green technology innovation. With the improvement of ESG performance, enterprises will actively fulfill their responsibilities in environmental, social, and governance aspects, which prompts enterprises to strengthen internal control and form an effective management system. This can reduce risks, resolve agency conflicts, and enhance the rationality of innovation investments, thereby making it more likely that funds will be invested in green technology innovation activities. At the same time, it can also strengthen the effective supervision of relational resources, realizing the interdependence and complementarity between resources and internal control. Therefore, enterprises should focus on establishing and perfecting their internal control systems to improve the efficiency and quality of corporate green technology innovation and promote the sustainability of corporate development.

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