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Research on the Impact of Green Technology Innovation on Corporate ESG Performance under the Concept of Green Development

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Abstract: With the concept of green development becoming increasingly deeply entrenched, Corporate ESG performance has emerged as a statistically important criterion for evaluating the level of sustainable development of industries, and green technological innovation serves as a vital practical approach. Although existing literature has extensively explored research on how green technological innovation impacts the ESG performance of enterprises technological innovation on corporate ESG performance remains relatively scarce. This paper chooses listed companies spanning the period 2013-2023 as its research samples, with the focus placed on analyzing the impact of green technological innovation on corporate ESG performance by constructing a regression model. It is shown by the research results that green technological innovation demonstrates a statistically significant impact on corporate ESG performance, and this promoting effect becomes more pronounced with the increase in investment in green technological innovation. Therefore, the study of the relationship between the two is conducive to providing theoretical support and practical guidance for the green development of enterprises, and also offers decision-making references for governments and social organizations to promote research and development of environmentally friendly technologies.

Keywords: Green Development; Green Technological Innovation; Corporate ESG Performance; Sustainable Development; Awareness of Environmental Responsibility

1. Introduction

China's the long-range objectives through 2035 and the 14th Five-Year Plan building a modernization featuring harmonious coexistence between humans and nature. Accordingly, coordinating environmental and economic development in a balanced way is imperative, particularly as China, s economy has transitioned away from high-speed expansion toward a model centered on high-quality development, which in turn raises higher demands for enterprises, green technological innovation capabilities. Technological innovation is the core driving force for green development. Integrating environmental protection concepts with new technologies into products, processes, management, and services is of great significance for reducing resource consumption, alleviating environmental pollution, and enhancing ecological benefits. A central tenet of a major national development plan was the cultivation of a green economy. Complemented by the sequential release of supportive policies, including the Implementation Plan for Further Enhancing the Market Oriented Green Technological Innovation System., highlighting the strategic position of green technological innovation.

Corporate ESG performance is a key indicator for measuring enterprises' development, covering environmental, social, development, and governance practices, with the aim of promoting the synergy of economic, environmental, and social benefits. In the past, some enterprises over pursued profits while neglecting environmental and social responsibilities, triggering a series of ecological problems. Today, under the guidance of the green development concept, enterprises need to take proactive actions in various fields to enhance their overall performance and attain sustainable development Green technological innovation is closely linked to corporate ESG performance. On one hand, guided by green concepts, green technological innovation reduces enterprises' pollution and costs, promotes their fulfillment of environmental responsibilities, and

improves performance in the "E" (Environmental) dimension. On the other hand, it helps enterprises optimize resource utilization, balance benefits, and facilitate the fulfillment of responsibilities in the "S" (Social) and "G" (Governance) dimensions.

The main contributions of this study are chiefly embodied in the four aspects that follow:

First, for enterprises: With the worsening environmental pollution and the growing environmental awareness of consumers, enterprises are not only facing pressures from stringent environmental regulations but also shouldering the mission of transformation and upgrading. Carrying out green technological innovation helps enterprises enhance their brand image and market share. The study presented in this paper can offer theoretical support for enterprises to pursue green development. Strengthen their competitiveness and innovation capabilities, and expand resources and channels for enterprises to better fulfill their ESG responsibilities.

Second, for the country: China stands at a key period of green development transformation, and this process urgently requires strong scientific and technological support from a large number of green technological innovations. The research in this paper holds important practical significance for China to achieve its sustainable development goals and assists the nation in advancing the synergistic development of economy and environment from a macro perspective.

Third, for the world: Against the backdrop of global warming, achieving green and low-carbon transformation is a common aspiration of all countries worldwide. As the core driving force for promoting this transformation, green technological innovation not only reshapes the global industrial chain but also builds a more resilient green economic system.

Fourth, for academic research: Current research primarily centers on the influence of green technological innovation on enterprises' economic aspects (such as industrial development and profitability), while research on corporate ESG performance remains relatively insufficient. Starting from environmental benefits, the present study examines the effect of sustainable technological innovation on firms' ESG performance, seeking to extend the research avenue of green tech innovation, enrich the connotation of academic research in this field, and reflect its theoretical value.

2. Literature Review

Key policy statements of a major conference are contained in its flagship report, which emphasizes "promoting the green and low-carbon development of the economy and society is a key link in achieving high-quality development". Li et al. (2022) [1] pointed out that Environmental, Social, and Governance (ESG) precisely embodies the trinity of sustainable development concept integrating economic development, environmental protection, and social equity. In 2004, the United Nations Global Compact first formally put forward the ESG concept in its relevant initiative. As a long-standing hot topic in academia, ESG has spawned numerous empirical studies. From existing literature, research on corporate ESG primarily focuses on two categories: external factors and internal factors. External Factors [2-4]. For instance, Chen et al. (2023) [2] employed a multiple regression model and found that institutional investor shareholding contributes to improving corporate ESG performance. Li et al. (2023) [3] revealed through their study that the development capacity enterprises, green tech innovation capabilities and digital inclusive finance work in tandem to promote corporate ESG performance. Kim et al. (2025) [4] discovered that foreign ownership boosts corporate ESG performance, driven by the improvement of standards and testing capabilities. Internal Factors [5-7]. Liang et al. (2022) [5] confirmed via empirical research that a higher degree of female participation in the board of directors leads to better corporate social responsibility performance. Liu (2025) [6] found that social security fund shareholding significantly elevates corporate ESG performance by promoting green innovation, enhancing internal control quality, and facilitating information disclosure. Chen et al. (2025) [7] indicated through analysis that enterprises founded by individual's enterprises bearing a cultural imprint of frequent flooding demonstrate stronger internal controls, a factor facilitating enhancements in their overall ESG performance and environmental outcomes.

Green technological innovation refers to technological innovation that advances sustainable development. Since the proposal of China's sustainable development concept, it has

stimulated more scholars to conduct research on this field [8-12]. Wu et al. (1996) [8] defined green technology, broadly defined as an umbrella term encompassing technologies, processes, or products that mitigate environmental pollution while reducing the consumption of raw materials, natural resources, and energy, has served as a foundation for extensive scholarly inquiry with studies both domestically and internationally. Have thoroughly explored the promotional role of green technological innovation at the national level. For example, Qiao et al. (2011) [9], from the perspective of low-carbon cost management, pointed out that green technological innovation reduces enterprises' green production costs and increases revenues, thereby improving financial performance. Zhang et al. (2025) [10] found through empirical analysis that enterprises' active practice of the innovation-driven development strategy and engagement in green technological innovation are conducive to enhancing corporate value. Sun et al. (2024) [11] measured enterprises' total factor productivity using a semi-parametric method and concluded that technological innovation driven by sustainability exerts a substantively positive effect on the productivity levels of enterprises.

In addition to studies on the positive impacts of green technological innovation, a small number of researches have focused on its negative effects. For example, Yang (2019) [12] verified through empirical research that enterprises' green technological innovation activities face certain financing constraints, which in turn restrict their development. A review of the aforementioned literature reveals that the majority of existing studies on technological innovation driven by sustainability adopt a perspective based on economic interest as their starting point, focusing on its impacts on corporate financial performance, market share, and other economic aspects. By contrast, scholarly inquiries into the link between technological innovation driven by sustainability and firms' ESG performance are still relatively limited in quantity.

3. Theoretical Analysis and Research Hypotheses

The resource dependence theory holds that for survival and sustainable development, enterprises must rely on and utilize multiple types of resources within the external environment, covering material resources as well as human resources, and financial resources. By acquiring and utilizing these resources, enterprises achieve continuous innovation and development [13-15], thereby improving their ESG performance. Wei (2023) [13] argued that enterprises' ability to promptly grasp environmental protection laws and policies issued by the government, industry development trends, and consumer demands helps provide necessary resources for technological innovation activities; the introduction of these resources can enhance enterprises' environmental performance. Zhu et al. (2025) [14] used the difference in differences (DID) method to examine the impact of Green Total Factor Productivity (GFPP) on corporate ESG performance and its mechanism. The findings of this study reveal that green total factor productivity significantly improves corporate ESG performance. Ning (2022) [15] believed that public participation exerts pressure on enterprises directly or indirectly, internalizing environmental responsibility awareness into corporate operational decisions and thus boosting innovation enthusiasm. Relying on the above analysis theoretical exploration, Hypothesis H1 is put forward:

H1: Green technological innovation has a significant impact on corporate ESG performance.

The institutional theory emphasizes the constraining and shaping role of institutions on the behavior of individuals and organizations, holding that institutions influence social structures and behaviors through rules, norms, and culture [16-18]. In 2021, the Ministry of Ecology and Environment clearly stated that an environmental information disclosure system should be basically established by 2025. Also, listed companies are mandated by the China Securities Regulatory Commission (CSRC) to disclose in detail the progress of their environmental and social responsibilities in annual reports. Huang (2023) [16] proposed that environmental regulation can strengthen local governments' punishment for environmental issues at the macro level, and promote enterprises' green transformation, upgrading, and increased environmental protection efforts at the micro level, all of which are conducive to improving corporate ESG performance. Li et al. (2025) [17] the research results indicate that green technological innovation (GTI) has

evolved into a core mechanism for boosting energy efficiency, cutting carbon emissions, and advancing the sustainable development of China's economy. Meanwhile, structural optimization and factor reallocation serve as effective pathways through which GTI drives advances in carbon productivity. Liu et al. (2023) [18], this study built a multi-period DID model, revealing that the low-carbon city pilot initiative elevates firms, ESG performance by spurring corporate green innovation efforts. Strengthening their sense of social responsibility, and improving their internal control. In light of the above theory, Hypothesis H2 is formulated as follows:

H2: Green technological innovation is positively correlated with corporate ESG performance.

4. Research Design

4.1 Data Sources

Constrained by data accessibility, this study extracts panel data of listed firms in China over the 2013–2023 period. Primary data for the analysis are drawn from three widely used databases: the China Research Data Services Platform (CNRDS), China Stock Market & Accounting Research Database (CSMAR), and Wind.

4.2 Variable Selection

4.2.1 Dependent variable: corporate ESG

From existing literature, The ESG evaluation framework in China has yet to achieve standardization and unification or fully refined. However, institutions such as Syn Tao Green Finance, Bloomberg, Hua Zheng, and Wind have developed ESG rating methods and content, which have become important reference bases for all sectors of society. Hua Zheng ESG incorporates rating indicators with Chinese characteristics. It also sets indicator weights differently according to industry adjustment characteristics. This enables it to measure corporate ESG performance more accurately. It is widely recognized and used in academia. Referring to the research of Xu (2025) [19], this study finally adopts the Hua Zheng ESG rating score as the representative indicator of corporate ESG rating.

4.2.2 Independent variable: green technological innovation (GTI)

Among prior research, the measurement metrics for firms' green technological innovation are primarily categorized into two types. Primarily, firms, green innovation performance is quantified through dual metrics: R&D expenditures and innovation yields. However, with the gradual improvement of China's green technology innovation capability, this research approach may have difficulty accurately evaluating the efficiency of enterprises, green technological innovation. The second type is green patent application counts which is generally used to reflect the efficiency of green technological innovation. Therefore, drawing on the research method of Wang et al (2021) [20], the level of enterprises' green innovation is reflected by the number of green invention patent applications.

4.2.3 Control variables

To fully control for various factors influencing corporate social responsibility to boost the precision of this study results, the present paper, building on prior research, selects the following variables as control variables: firm size (Size), asset-liability ratio (Leve), firm age (Age), profitability (Ros), board size (Board), and the shareholding ratio of the largest shareholder (Balance), as shown in Table 1.

Table 1. Variable Definition Table

Variable Explanation	Variable Symbol	Variable Meaning	Variable Measurement Method
Explained Variable	ESG	Corporate ESG Performance	Hua Zheng ESG Comprehensive Rating
Explanatory Variable	GTI	Green Technological Innovation	Ln (Total Number of Green Patent Applications + 1)
Control Variable	Size	Corporate Scale	Natural Logarithm of Total Corporate Assets
	Leve	Asset - Liability Ratio	Total Liabilities / Total Assets
	Age	Corporate Age	Natural Logarithm of the Number of Years Since Corporate Establishment
	Ros	Profitability	Net Profit / Total Assets
	Board	Board Size	Natural Logarithm of the Number of Board Members
	Balance	Shareholding Ratio of the Largest Shareholder	Number of Shares Held by the Largest Shareholder / Total Number of Shares

4.3 Model Construction

For the purpose of examining how green technology innovation influences enterprises, performance of social responsibilities, this paper develops the model presented below.

$$ESG_{i,t}=a_0+a_1GTI_{i,t}+a_2Size_{i,t}+a_3Leve_{i,t}+a_4Age_{i,t}+a_5Ros_{i,t}+a_6Board_{i,t}+a_7Balance_{i,t}+\varepsilon$$

In the model, ESG is the explained variable, GTI is the explanatory variable, i represents the enterprise, t represents the year, and ε is the disturbance term of the model.

5. Empirical Results Analysis

The table presents the results of the descriptive statistical analysis for key variables. With respects to green technological innovation (GTI), the maximum value is 7.524, the minimum value is 0.000, and the mean value is 0.898 thus indicating significant differences in the level of green technological innovation among different enterprises. For corporate ESG performance, the maximum value is 92.930, the minimum value is 36.620, and the mean value is 73.218, which shows substantial variations in the development level of corporate ESG. Among the control variables, the standard deviations of the asset-liability ratio and profitability are relatively large, while those of firm size, firm age, board size, as well as the ownership stake ratio of the largest shareholder are relatively small, with no significant differences in their overall levels. Table 2 presents detailed outcomes of descriptive statistics.

Table 2. Descriptive Statistics

Stats	ESG	GTI	SIZE	LEVE	AGE	ROS	BOARD
Mean	73.218	0.898	22.321	0.432	2.954	0.032	2.115
Median	73.450	0.000	22.064	0.410	2.996	0.035	2.197
Max	92.930	7.524	31.431	178.346	4.220	108.366	3.045
Min	36.620	0.000	14.942	-0.195	0.693	-30.688	1.386
SD	5.217	1.223	1.504	0.952	0.324	0.616	0.205
N	38545	38545	38545	38545	38545	38545	38545

According to the correlation analysis between variables as shown in Table 3, green technological innovation (Innovation) and corporate ESG (TFP) have a correlation coefficient of 0.167, significant at the 1% level, his confirms Hypothesis 1 stating that green technological innovation exerts a significant effect on corporate ESG performance.

Table 4 presents the regression results of green technological innovation and corporate ESG performance. In the empirical results, the coefficient of green technological innovation reaches 0.274., under the condition of a 1% significance level, thus indicating that increasing green technological innovation promotes corporate ESG performance, which fully verifies Hypothesis H2.

Table 3. Correlation Analysis

	ESG	GTI	SIZE	LEVE	AGE	ROS	BOARD
ESG	1						
GTI	0.167	1					
SIZE	0.262	0.424	1				
LEVE	-0.053	0.042	0.091	1			
AGE	-0.027	0.039	0.181	0.049	1		
ROS	0.034	0.001	-0.006	-0.290	-0.006	1	
BOARD	0.063	0.110	0.346	0.044	0.087	-0.003	1

Meanwhile, the analysis of relevant control variables in the regression results shows that firm size (Size), asset-liability ratio (Leve), firm age (Age), profitability (Ros), and board size (Board) is positively associated with corporate ESG performance at the 1% level of significance. Detailed regression analysis is shown in Table 4.

Table 4. Empirical Results

	(1)
VARLABLES	TFP
GTI	0.2744***
	(0.4590)
Size	0.9137***
	(0.0201)
Leve	-0.3881***
	(0.0280)
Age	-1.1470***
	(15.5290)
Ros	0.1236***
	(0.0431)
Board	-0.6496***
	(0.1322)
cons	57.5029***
	(0.4590)
Observations	38545
R-squared	0.0844

Note: ***,**and* denote statistical significance at the 1%, 5%, and 10% levels, respectively (with t-values in parentheses).

6. Conclusions and Recommendations

The data for this paper are sourced from Chinese listed companies, covering the period from 2013 to 2023. The data are mainly obtained from the China Research Data Services Platform (CNRDS), the China Stock Market & Accounting Research Database (CSMAR), and Web of Science. A linear regression model is adopted, with relevant variables incorporated, to achieve the purpose of studying the relationship between green technological innovation and corporate ESG performance.

This paper finds that in the development process of enterprises; green technological innovation plays a very important role and has a very obvious impact on corporate ESG performance. We can say that green technological innovation is positively correlated with corporate ESG performance, namely, the more investment there is in green technological innovation R&D, the better the corporate ESG performance will be. It is not difficult for us to see that green technological innovation, on the one hand, has an effect on corporate ESG performance, and on the other hand, can also produce positive results, which plays a great role in promoting the improvement of corporate ESG performance.

Building on the foregoing conclusions, this research advances the following recommendations:

First, policies are an important guarantee for promoting green innovation. The government should formulate a series of policy measures to guide enterprises in improving their ESG performance. For example, it can introduce preferential tax policies and financial subsidies to encourage businesses are ramping up their spending on green innovation. In addition, the state should improve relevant laws and regulations, impose heavier penalties on enterprises that cause environmental pollution, and provide legal guarantees for enterprises' green innovation efforts.

Second, public awareness is a crucial driving force for green innovation. As people's environmental awareness in society grows, they tend to prefer products derived from green technological innovation, thereby spurring firms to pursue development green technology products.

Third, Firms serve as the primary agents of green innovation. Enterprises should formulate relevant green innovation strategies based on their own conditions and market demands, and clearly define the goals and development directions for their green innovation initiatives.

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