

The Impact of Corporate ESG Performance on Corporate Green Innovation

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Abstract. The incorporation of green innovation by firms is considered essential to attain superior developmental outcomes. This study aims to examine how ESG (Environmental, Social, and Governance) performance influences green innovation and delve into the mechanisms that facilitate its implementation based on data spanning from 2011 to 2021, with a particular emphasis on companies listed on the A-share market in China. Its primary. The research findings substantiate that robust ESG performance by enterprises plays a pivotal role in driving green innovation. This influence can be attributed to several key factors within the implementation mechanism. Firstly, companies exhibiting excellence in ESG performance tend to demonstrate heightened social responsibility. Secondly, commitment to comprehensive and transparent information disclosure practices is more pronounced among such companies. Lastly, easier navigation of financing constraints is often observed, facilitating their green innovation initiatives. Drawing upon this analysis, valuable suggestions are proposed, emanating from ESG information disclosure practices and their influence on fostering green innovation. The study underscores the importance of integrating environmental, social, and governance considerations into corporate strategies as a means to usher in an era of sustainable, high-quality development for firms.

Keywords: Enterprise ESG performance; Green innovation; Social responsibility; Information disclosure; Financing constraint.

1. Introduction

China's robust economic growth in recent decades has brought to the forefront the pressing concerns of energy and environmental issues, notably the adverse effects stemming from the extensive utilization of fossil fuels on the environment. Green innovation, as a key means of restructuring the energy landscape and mitigating environmental degradation, becomes a critical measure to address this problem. With the proliferation "Green sustainable development" traditional financial performance-oriented information disclosure can no longer comprehensively demonstrate a company's management advantages and development prospects, failing to meet the information needs of investors. Instead, the practice of divulging information related to ESG factors has progressively captured the interest of both domestic and international investors.

ESG, representing Environmental, Social Responsibility, and Corporate Governance, relates to a corporation's impact on the environment, its dedication to societal duties, and its internal management practices. Existing domestic and international studies predominantly emphasize the economic outcomes associated with ESG, while allocating limited consideration to its influence on corporate innovation. Previous studies have shown that ESG performance has the potential to boost corporate performance, facilitate the financial growth of companies, and enhance the value of companies with varying ownership structures, all while mitigating corporate financing expenses [1]. For instance, advanced corporate governance can enable the release of information regarding a company's social responsibilities, ultimately enhancing the company's long-term value. However, green innovation as a new branch of corporate innovation has received little attention. In this context, this thesis conducts

an empirical analysis of how ESG performance influences the development of green technology, utilizing publicly traded companies as the focal point for research from 2011 to 2021. It also investigates how corporate ESG performance impacts green technology innovation by reinforcing internal oversight, enhancing ESG information disclosure, and mitigating financing expenses. This study provides a methodical exploration of how corporate ESG performance influences the realm of green technology innovation.

The potential contributions of this study conclude: 1) it provides specific perspectives on the link between corporate ESG ratings and green innovation, as well as the underlying mechanisms, introducing a fresh angle regarding the factors that influence the development of corporate green technology innovation. The research findings delve into the role of ESG ratings in advancing environmental transformation and enrich the results concerning global ESG practices; 2) it uncovers the circumstances under which ESG performance drives innovation in corporate green technology and, as a result, offers suggestions for enhancing the efficacy of green technology innovation by improving ESG performance.

2. Theoretical Foundation

ESG comprises the initials representing Environment, Social Responsibility, and Corporate Governance, encompassing a comprehensive evaluation that considers external governance, internal responsibilities, and environmental factors. This paper analyzes the Pathways of influence of social responsibility, ESG rating disclosure, and financing cost to examine the influence trajectories of a company's ESG performance on its green innovation.

First, in terms of social responsibility, ESG ratings in social responsibility effectively binds companies and promotes their green innovation. Companies are affected by government regulations and environmental pressures. In order to be socially responsible, enhance their corporate reputation, and obtain higher ESG ratings, they need to minimize or even eliminate their negative impacts on the environment on the basis of relevant environmental regulations and national standards [2]. This social responsibility requirement may prompt companies to increase their investment in innovation in areas such as greening and environmental protection. They will be able to develop more energy-efficient and low-carbon production technologies and products. This will increase the effectiveness of resource use and help to realize the objective of sustainable development. This creates an internal driving force for green technological advancement, simultaneously bestowing competitive benefits upon companies engaged in green innovation, resulting in the establishment of a virtuous cycle [3]. Social responsibility requires companies to consider the interests and needs of other stakeholders (e.g., consumers, employees, communities, etc.) in the context of their business operations. These allow companies to have sufficient funds and greater incentives for green innovation, leading to a higher social reputation and a better brand image.

Information asymmetry between stakeholders and companies is efficiently addressed by ESG rating disclosure. In addition to corporate governance, managerial effectiveness, and financial health, it considers sustainable development and CSR [4]. This reduces the difficulties of obtaining money for green development and helps financial institutions better grasp the non-financial and financial facts of businesses during credit evaluation [5, 6]. In addition, institutional investors prefer companies with better ESG rating results, thus avoiding the risk of adverse selection [7]. This can reduce the difficulty of the inflow of external funds into companies, thus addressing the issue of inadequate funding for green innovation R&D and promoting enterprises to be more active in green innovation [8].

In terms of reducing financing expenses, a company's progress relies on the availability of stable financing channels, an essential prerequisite for ensuring the long-term sustainability of businesses. ESG rating can represent a company's internal governance level, and companies with a high level of internal governance usually establish sound performance evaluation and incentive and constraint mechanisms, which can mitigate principal-agent conflicts and avoid incentive misalignment and

moral hazard problems. Thus, managers have incentives to make decisions that are conducive to increased economic benefits and green and sustainable development. ESG ratings make it easier for investors and financial institutions to keep abreast of a company's situation and deepen their understanding of the company, so such companies are also more popular with investors, which in some ways reduces the cost of financing for the company [9].

Building upon the preceding analysis, this paper presents the following hypothesis: The ESG performance of companies has a favorable influence on their green innovation.

3. Method

3.1. Data Collection

As research subjects, this study focuses on A-share listed companies in China spanning the period from 2011 to 2021. The selection process for the samples proceeds as follows: (1) Excluding ST and *ST-designated samples; (2) Eliminating samples with an asset-liability ratio exceeding 1; (3) Removing samples with missing data; (4) 1% and 99% indentation were performed for continuous variables. Ultimately, 28777 sample observations from an uneven panel of data are acquired. The ESG information is based on the ratings returned by China Securities' ESG evaluation system. The Wind database provided some of the data, while the CSMAR database provided other data.

3.2. Model Setting and Variable Definition

This study establishes a regression model to explore the correlation between ESG performance and the advancement of green innovation:

$$GREINO = \alpha + \beta_1 ESG + \beta_l \sum_{l=2}^{10} CV + \sum Ind + \sum Year + \varepsilon \quad (1)$$

In formula (1), GERINO serves as the dependent variable, representing the level of green innovation within the enterprise. To measure GERINO, this study employs the natural logarithm of the count of green patent applications incremented by plus 1; The China Securities ESG index serves as the explanation factor for ESG, measuring the ESG performance of companies. CV is control variable, referring to the research of Yadu Zhang [5], including asset-liability ratio (Lev), cash holding level (cashhold), profitability (roa), ownership concentration (ec), proportion of independent directors (Rib) and enterprise age (age). Ind corresponds to the fixed effect specific to the control industry. Year, on the other hand, signifies the fixed effect pertaining to the year. ε represents the random error term. Table 1 displays the precise definitions of the variables.

Table 1. Variable table.

Variable type	Variable name	Variable symbol	Variable definition and calculation
Explained variable	Green innovation	GERINO	Multiply the number of applications for green patents by one to take the natural logarithm
Explanatory variable	ESG performance	ESG	China Securities ESG Index
	Enterprise age	Age	Establishment period
	Asset-liability ratio	Lev	Total liabilities/total assets
Control variable	Ownership concentration	Ec	The percentage of a listed company's largest shareholder's shares
	Proportion of independent directors	Rib	Number of independent directors/Total number of board members
	profitability	Roa	Net profit/total assets
	Cash holding level	Cashhold	Total cash and its equivalents/total assets

4. Analysis of empirical results

4.1. Overview of Descriptive Statistics

Table 2 provides an overview of descriptive statistics, demonstrating that the average GERINO value stands at 1.613743, with a minimum of 0 and a maximum reaching 9.513182. The standard deviation is 1.630951, suggesting significant variability in green innovation levels among the sampled enterprises. Overall, the sample enterprises demonstrate a low level of green innovation, with considerable variation across different companies. The mean value of ESG is 6.508028, the minimum value is 1, the maximum value is 9, and the standard deviation is 1.143594, manifesting that the spread of ESG performance of corporations is relatively average.

Table 2. Descriptive statistics.

Variable	Obs	Mean	Std. dev.	Min	Max
gerino	28,776	1.613743	1.630951	0	9.513182
esg	28,776	6.508028	1.143594	1	9
age	28,776	11.638	7.424359	2	32
lev	28,776	0.4270892	0.2058471	0.00708	0.997603
ec	28,776	34.1406	14.97222	0	90
rib	28,776	0.3795476	0.0661762	0.1875	0.8
roa	28,776	14388.13	8306.656	1	28775
cashhold	28,776	13594.09	7878.722	1	27459

4.2. Basic Regression Analysis

The results of the regression analysis, which explores the relationship between ESG performance and green innovation, are presented in Table 3. In column (1) of Table 3, can observe that even after accounting for industry and year variables, the ESG coefficient stands at 0.039, displaying noteworthy statistical significance at the 1% confidence level. Notably, this significant coefficient positively impacts the promotion of green innovation. In Table 3, within column (2) while controlling for province and year variables, the ESG coefficient stands at 0.076, demonstrating a statistically significant positive impact on green innovation at the 1% level. These findings support the validity of hypothesis H1 in this study, indicating that ESG performance has the ability to drive green innovation.

Table 3. Corporate ESG performance and green innovation.

	(1)	(2)
	Enterprise and province	Province and year
ESG	0.039*** (0.007)	0.076*** (0.005)
age	0.013*** (0.002)	-0.003*** (0.001)
Lev	-0.147*** (0.054)	0.887*** (0.028)
Ec	0.000 (0.001)	0.002*** (0.000)
Rib	-0.070 (0.103)	0.051 (0.074)
Roa	0.290*** (0.070)	0.573*** (0.059)
cashhold	-0.215*** (0.063)	-0.300*** (0.044)
_cons	1.315*** (0.078)	-0.357*** (0.043)
N	28416	28776

4.3. Robustness Analysis

In order to bolster the conclusion's credibility, this study undertook additional analyses to ensure robustness: the explained variables were refined, and the enterprise green innovation was subdivided into green invention patents (column 1, column 2) and green utility model patents (column 3, column 4), and the regression was conducted as explained variables respectively. The robustness test outcomes are presented in Table 4. All ESG coefficients pass the robustness test and are conspicuously positive at the 1% level.

Table 4. Robustness test.

	(1)	(2)	(3)	(4)
	Enterprise and province	Province and year	Enterprise and province	Province and year
ESG	0.039*** (0.005)	0.110*** (0.005)	0.032*** (0.005)	0.076*** (0.005)
age	0.056*** (0.001)	-0.000 (0.001)	0.046*** (0.001)	-0.003*** (0.001)
Lev	0.243*** (0.036)	0.822*** (0.030)	0.245*** (0.036)	0.887*** (0.028)
Ec	0.000 (0.001)	0.000 (0.000)	-0.000 (0.001)	0.002*** (0.000)
Rib	-0.066 (0.067)	0.148* (0.078)	-0.035 (0.069)	0.051 (0.074)
RoA	0.164*** (0.046)	0.535*** (0.062)	0.157*** (0.046)	0.573*** (0.059)
cashhold	-0.022 (0.042)	0.045 (0.046)	0.001 (0.042)	-0.300*** (0.044)
_cons	-0.451*** (0.051)	-0.612*** (0.045)	-0.308*** (0.052)	-0.357*** (0.043)
N	28416	28776	28416	28776

Standard errors in parentheses

* p < 0.1, ** p < 0.05, *** p < 0.01

5. Conclusions

This study investigates the impact of ESG performance on both the promotion of green innovation and its underlying implementation process, utilizing the fixed-effect model. The research reveals that the performance in ESG factors within corporations primarily fosters green innovation through a triad of mechanisms: strengthening corporate social responsibility, deepening corporate ESG disclosure, and reducing corporate financing costs. Based on the aforementioned findings, this study derives the following insights: Initially, government authorities should enhance their oversight and direction of ESG practices. They ought to establish and refine the ESG reporting framework, which includes defining obligatory disclosure criteria and creating an integrated ESG performance assessment system. Furthermore, it is imperative to extend corresponding policy backing to foster enterprises' innovation in green technology. This, in turn, will further enhance the role of ESG performance in driving advancements in eco-friendly technology. Investors should also prioritize the substance and quality of enterprises' disclosures regarding ESG information. They should thoroughly assess both the present situation and future prospects of heavily polluting enterprises, effectively averting potential investment hazards. Third, enterprises should positively react to the appeal of the government, improve the level of ESG information disclosure, fully demonstrate their comprehensive ability of sustainable development through ESG information disclosure, and incorporate ESG into corporate investment decisions to meet the needs of stakeholders for corporate environmental, social responsibility and corporate governance information. Simultaneously, we should emphasize substantive green innovation and harness the constructive impact of ESG information disclosure to

drive forward substantive green innovation. This, in turn, will elevate the overall performance level of green innovation.

Authors Contribution

All the authors contributed equally and their names were listed in alphabetical order.

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