Research on Whether ESG Performance Can Promote the Improvement of Innovation Level in Manufacturing Enterprises: An Empirical Analysis Based on A-Share Listed Manufacturing Companies

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Abstract. This study examines how environmental, social, and governance (ESG) performance influences innovation in Chinese A-share manufacturing firms (2014–2023) using computational panel regression methods. Results show that improved ESG performance significantly boosts patent applications, particularly inventions, while firm size and profitability positively moderate innovation. The relationship between industry competition and innovation follows an inverted U-shape. The analysis leverages advanced statistical software for data processing and model validation, supporting the integration of ESG strategy into R&D planning for sustainable development.

Keywords: Corporate ESG Performance, Corporate Innovation, Sustainable Development, Manufacturing Industry

1 Introduction

1.1 Research Background

In recent years, academia has placed great emphasis on the relationship between corporate innovation and ESG practices. ESG, as a comprehensive evaluation system, covers three dimensions: environment, social responsibility, and corporate governance, providing a holistic assessment of an enterprise's operational status, growth potential, and sustainable development capabilities. With the rise of computational tools, researchers increasingly rely on data-driven approaches to analyze ESG impacts.

Existing research has explored the relationship between ESG performance and corporate value and innovation from multiple dimensions, yielding rich results. From the perspective of corporate value, Chen Hong et al. found that ESG performance significantly enhances book value and market value, with digital transformation playing a positive moderating role [1]. Wang Bo et al. further verified the mechanisms through which ESG performance enhances corporate value from the dimensions of

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financing costs and market attention [2]. However, Liu Yi et al. also found industry heterogeneity in the relationship between ESG performance and corporate value [3]. From the innovation perspective, ESG performance promotes corporate innovation through multiple paths: First, Li Yuanyuan et al. showed that ESG performance can enhance corporate value by promoting green innovation [4]; second, Yao Shujie et al. pointed out that improved ESG performance implies more environmental investments and technological innovation inputs [5]. In terms of financing constraints, Xie Hongjun et al. found that enterprises with ESG advantages are more likely to gain trust from financial institutions, reducing financing constraints during innovation [6]. Fang Xianming et al. further confirmed that ESG disclosure can transmit corporate information to the outside world, alleviating information asymmetry and increasing external funding supply [7]. Additionally, from a governance mechanism perspective, Chen Deqiu et al. found that ESG helps improve employee innovation efficiency and optimize human capital structure [8]. Guo Yue, by constructing a government innovation subsidy signal transmission mechanism model, verified that innovation subsidies not only provide direct R&D funding but also transmit positive signals through technical review and dynamic supervision, thereby promoting corporate innovation [9].

This study focuses on the manufacturing industry, a pillar of China's economy, to deepen the understanding of the relationship between ESG and corporate innovation. Manufacturing enterprises, characterized by high resource consumption, significant environmental impact, and complex supply chains, may have unique mechanisms through which ESG practices influence innovation. Simultaneously, it will reveal the differential effects of various influencing factors on ESG-driven innovation in manufacturing enterprises, enriching the applicability boundaries of relevant theories.

1.2 Research Methods

This study employs computational panel data regression methods to examine the impact of ESG performance on innovation in manufacturing enterprises. Panel data regression accounts for both time and individual dimensions, allowing for a more accurate revelation of the relationship between ESG performance and corporate innovation. The analysis is implemented using Stata17 and SPSS25, which provide robust computational environments for handling large-scale data. After obtaining panel data, this paper uses Stata17 for data processing, including data cleaning, outlier detection, and winsorization at the 1% level to mitigate extreme values. Non-manufacturing industry data are excluded, and the study period is controlled to 2014–2023.

In the analysis, a baseline regression model is constructed computationally, incorporating control variables such as enterprise age, scale, profitability, and industry competition. SPSS25 is utilized for statistical validation, ensuring reliability through automated algorithms for hypothesis testing and coefficient estimation. Through computational regression analysis, the study delves into how ESG performance across dimensions (e.g., environmental protection, social responsibility, corporate governance) promotes innovation activities, and further explores moderating effects using interactive terms and robustness checks.

2 Research Hypotheses and Research Design

2.1 Research Hypotheses

In recent years, with worsening social issues and increased public focus on sustainability, ESG has become a key direction for corporate development. Government policies and rising public environmental awareness compel enterprises to adopt low-energy, low-pollution technologies to achieve sustainable development goals. In this process, ESG-advantaged enterprises can reduce innovation costs and enhance innovation capability through policy support like tax incentives and subsidies.

Based on this, hypothesis H1 is proposed: ESG advantages can effectively enhance corporate innovation output.

Furthermore, by analyzing domestic literature, it is argued that superior ESG performance enhances resource integration and R&D investment capability, thereby driving technological innovation and invention patent applications. Specifically, excellent ESG performance may encourage enterprises to focus more on long-term technological accumulation, promoting forward-looking and breakthrough R&D, ultimately increasing invention patent applications. Compared to invention patents, utility model patents reflect practical applications and improvements of existing technology, focusing on optimization and meeting market demands. Increases in utility model patents indicate innovation capability at the application level, which can more directly address market and social needs, enhancing competitive advantage.

Based on this, hypotheses are proposed:

H2a: ESG advantages promote corporate innovation by increasing invention patent applications.

H2b: ESG advantages promote corporate innovation by increasing utility model patent applications.

These hypotheses aim to reveal how ESG advantages drive innovation through different types of patent applications, providing theoretical support for enterprises to leverage ESG for innovation.The specific theoretical framework is shown in Figure 1.

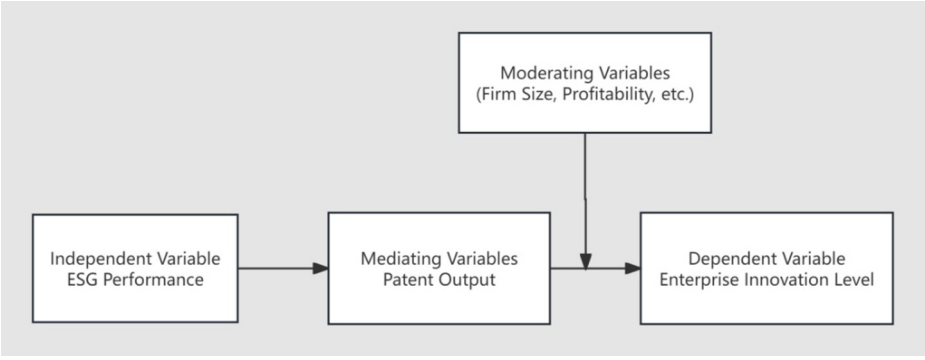

Fig. 1. Theoretical Model

2.2 Research Design

Data Sources and Sample Selection.

Given the availability of ESG information and corporate patent data, this study selects listed companies in the manufacturing sector on the Shanghai and Shenzhen A-share markets from 2014 to 2023 as the analysis sample. To ensure data quality, samples with missing data, those labeled as "special treatment" (ST), and enterprises with few annual observations are excluded, resulting in a dataset of 20,490 manufacturing enterprise-year observations. Computational tools like Stata17 are used for data integration and validation. To measure innovation capability, this study adopts patent numbers as key indicators, following methods like Fang Xianming et al., with patent data sourced from the Chinese Research Data Service Platform (CNRDS) [10]. Additionally, considering the coverage of ESG rating systems, Huazheng ESG ratings are used as a proxy for corporate ESG performance. Huazheng Index has conducted ESG assessments since 2009, covering all A-share listed companies and being widely recognized in academia and industry. Huazheng ESG data are provided by Wind, while other financial and industry-specific data come from CSMAR. To mitigate extreme values, continuous variables are winsorized at the 1% level computationally, and data processing and model estimation are performed using Stata17 and SPSS25.As shown in Table 1, the descriptive statistical results of the main variables in this study are as follows:

Table 1. Descriptive Statistics of Main Variables

Variable	Obs	Mean	Std. dev.	Min	Max
Patent application	20,490	3.467287	1.510306	0	7.334329
Invention patent application	20,490	2.517225	1.487882	0	6.556778
Utility model patent application	20,490	2.657695	1.565058	0	6.36647
ESG performance	20,490	4.114031	0.9307739	1	7.75
Corporate age	20,490	2.055853	0.8275301	0	3.526361
Ownership concentration	20,490	32.40276	13.79209	8.704	70.5257
Cash holdings	20,490	15.23674	11.31147	0.9679	56.4526
dual roles combined	20,490	0.3471938	0.4760896	0	1
Fixed asset ratio	20,490	21.88192	12.90216	1.6362	60.3113
Enterprise growth rate	20,490	14.61986	34.52945	−49.2588	200.0282
Industry competitiveness	20,490	0.1522626	0.1064405	0.0391	0.6665
The square of industry competition	20,490	0.0345129	0.0586336	0.0015288	0.4442222
Proportion of independent directors	20,490	37.7759	5.322711	33.33	57.14
Leverage ratio	20,490	39.12034	18.97793	5.9511	89.8115
Executive shareholding ratio	20,490	16.932	20.47822	0	69.404
Book–to–market ratio	20,490	0.5871926	0.2338533	0.1186	1.1575
Profitability	20,490	3.769441	6.594929	−24.9642	20.4145
Company size	20,490	12.89609	1.156918	10.75701	16.48248
Property attribute	20,490	0.2352855	0.4241875	0	1

Model Specification.

To explore the mechanism of ESG performance on innovation capability in manufacturing enterprises, the following model is constructed:

$$\text{Innovation}_{i,t} = \alpha_0 + \alpha_1 \text{ESG}_{i,t} + \alpha_2 \text{Controls}_{i,t} + \Sigma \text{Year} + \varepsilon$$

In this model, ıand trepresent specific enterprises and years, respectively. The dependent variable Innovation_Level represents corporate innovation capability. This study uses the natural logarithm of the total number of invention, utility model, and design patents applied for independently by listed companies plus 1 as the primary indicator. Given the high originality value of invention patents, the natural logarithm of invention patent applications plus 1 is also used as another key indicator. To control for lagged effects of ESG on innovation, the dependent variable is lagged by one period. The explanatory variable is Huazheng ESG rating, which ranges from C to AAA, corresponding to values 1–9, reflecting ESG performance levels. Control variables include enterprise age (logarithmized), ownership concentration, cash holdings, duality (whether chairman and CEO roles are combined), fixed asset ratio, growth rate, industry competition and its square, proportion of independent directors, leverage, executive shareholding, book-to-market ratio, profitability, scale, and ownership attributes, following Fang Xianming and Cai Qingfeng et al. [10, 11]. Year fixed effects are controlled computationally to account for macroeconomic factors.

3 Regression Tests and Results

3.1 Baseline Regression Results

Table 2 presents the computational baseline regression results of the impact of ESG on corporate innovation level. The standardized coefficient of ESG is 0.152, with a p-value less than 0.05, indicating a significant positive effect of ESG performance on innovation level. Specifically, as ESG rating improves, the number of invention, utility model, and design patent applications is expected to increase on average in the following year. This finding supports hypothesis H1, showing that ESG advantages significantly promote innovation input and output. It verifies that ESG performance not only enhances social responsibility and environmental governance but also drives innovation, particularly in depth and breadth.

Regarding control variables, enterprise age has a negative effect on patent applications. As enterprises age, they may become more stable, with accumulated cash flow and scale leading to organizational redundancy, reducing innovation motivation and output. This suggests an inverse relationship between corporate life cycle and innovation dynamism. Enterprise scale shows a significant positive correlation with patent applications, aligning with the expectation that larger scale and profitability accompany increased R&D investment and innovation output. Larger enterprises have more resources and funds to boost R&D, enhancing innovation quantity and quality. However, the fixed asset ratio has a negative coefficient, indicating that higher fixed asset investment may crowd out innovation resources, limiting innovation capability. Addi-

tionally, cash holdings, book-to-market ratio, and ownership concentration negatively affect innovation, consistent with Yu Yihua et al. (2018), where high cash holdings and concentration lead to conservative decisions and lack of innovation incentives [12].

From industry characteristics, profitability and industry competition intensity have positive coefficients, indicating that higher profitability provides more resources for innovation, while increased competition drives innovation to maintain competitiveness. However, the squared term of industry competition is significantly negative, showing an inverted U-shaped relationship. Moderate competition stimulates innovation, but excessive competition may force enterprises to focus on short-term pressures, reducing original innovation.

Table 2. Baseline Regression Results

	Non-standardized coefficient		Standardized coefficient		
	B	**standard error**	**Beta**	**t**	**Significance**
(Constant)	−6.351	0.13		−48.751	0.000
ESG performance	0.244	0.01	0.15	24.406	0.000
Corporate age	−0.047	0.014	−0.026	−3.43	0.001
Company size	0.716	0.011	0.549	65.407	0.000
Fixed asset ratio	−0.018	0.001	0.156	−25.911	0.000
Enterprise growth rate	−4.67E−05	0.000	−0.001	−0.179	0.858
Cash holdings	−0.004	0.001	−0.028	−4.331	0.000
Leverage ratio	0.007	0.001	0.089	11.883	0.000
Book-to-market ratio	−0.324	0.043	−0.05	−7.578	0.000
Proportion of independent directors	0.000	0.002	−0.001	−0.189	0.85
Profitability	0.003	0.002	0.012	1.735	0.083
Ownership concentration	0.003	0.001	0.028	−4.864	0.000
Industry competitiveness	0.940	0.207	0.066	4.535	0.000
The square of industry competition	−1.808	0.376	0.07	−4.81	0.000
Executive shareholding ratio	0.004	0.001	0.051	7.579	0.000

3.2 Robustness Tests

To verify the reliability of the benchmark regression results, this study conducts computational robustness checks by employing the method of alternative dependent variables. Specifically, the number of invention patent applications (representing substantive innovation) and the number of utility model patent applications (representing

applied innovation) are used as dependent variables for re-estimation using Stata17. Table 3 synthesizes the key results from these two tests, aiming to compare the differential impact of ESG performance on distinct types of patents.

Table 3. Robustness Test

Variable	Invention patent application	Utility model patent application	Significance (invention)	Significance (Practical)
ESG performance	0.078	0.03	ignificant ($p<0.05$	ignificant ($p<0.05$
Corporate age	−0.043	0.02	Significant	Significant
Company size	0.372	0.039	Significant	Significant
Fixed asset ratio	−0.064	−0.046	Significant	Significant
Industry competitiveness	−0.156	0.241	Significant	Significant
Industry competition squared term	0.058	−0.165	Significant	Significant
Profitability	−0.027	0.031	Significant	Significant
Ownership concentration	−0.032	0.004	Significant	Not significant

The tests confirm that ESG performance exerts a significantly positive influence on both patent types, but its promoting effect is stronger for invention patents. This indicates that ESG advantages are more inclined to foster high-risk, high-originality substantive innovation rather than incremental technical improvements. Thus, both hypotheses H2a and H2b are supported, with the empirical effect for H2a (invention patents) being more pronounced.

Regarding the differential impacts of the control variables, firm age negatively affects invention patents (β = -0.043) but shows a weak positive influence on utility models (β = 0.020). This suggests that older firms tend to avoid radical innovation, shifting their focus towards lower-risk improvements. The analysis of industry competition intensity reveals an inverted U-shaped relationship for both patent types (opposite signs for the linear and squared terms), but with divergent directions. For invention patents, competition shows a suppressive effect (linear term β = -0.156), possibly because excessive competition deters firms from long-term R&D investments. Conversely, utility model patents are encouraged by competition (linear term β = 0.241), implying that market competition more directly stimulates applied innovation. Meanwhile, the fixed asset ratio negatively impacts both patent types, confirming the crowding-out effect of heavy asset structures on innovation resources.

Through these computational robustness checks, the positive effect of ESG on corporate innovation remains stable after substituting the dependent variables, and its influence exhibits clear heterogeneity across patent types. This result strengthens the mechanism whereby ESG drives long-term competitiveness by promoting high-end technological innovation, providing an empirical basis for integrating ESG strategy into corporate innovation planning.

4 Conclusion

This study empirically examines the impact of ESG performance on innovation in Chinese A-share listed manufacturing companies from 2014 to 2023. The findings confirm that superior ESG performance significantly promotes corporate innovation output, particularly in terms of invention patents. The results validate the research hypotheses, indicating that ESG advantages enhance innovation through multiple channels, including improved resource allocation and stronger incentives for long-term R&D.

The main conclusions are as follows: First, a positive ESG performance is significantly associated with a higher level of overall patent applications, supporting hypothesis H1. Second, the positive effect of ESG is more pronounced for invention patents (high-originality innovation) than for utility model patents (incremental innovation), supporting both H2a and H2b, with a stronger effect observed for H2a. Third, firm characteristics such as size and profitability positively moderate innovation, while firm age and a high fixed-asset ratio exhibit negative influences. Fourth, the relationship between industry competition and innovation follows an inverted U-shape, indicating that moderate competition is beneficial, whereas excessive competition may hinder substantive innovation.

The study provides important policy and managerial implications. For policymakers, it underscores the importance of refining ESG evaluation systems and incentive mechanisms to guide manufacturing firms towards sustainable innovation. For corporate managers, integrating ESG principles into strategic planning and R&D processes is crucial for fostering core technological competitiveness and achieving long-term sustainable development.

This research has certain limitations. The sample is limited to A-share listed manufacturing firms, and the findings may not be fully generalizable to unlisted or non-manufacturing enterprises. Future studies could expand the sample scope, employ more granular measures of innovation quality (e.g., patent citations), and explore the potential non-linear relationships or mediating mechanisms between ESG and innovation in greater depth.

References

1. Chen, H., & Zhang, L. (2023). ESG performance, digital transformation, and corporate value enhancement. Journal of Zhongnan University of Economics and Law, (3), 136-149.
2. Li, Y., Yin, J., & Qian, J. (2023). ESG performance and green innovation. Journal of Nanjing University of Finance and Economics, (2), 32-42.
3. Yao, S., & Jiang, Y. (2023). The path to sustainable development: ESG practices and corporate innovation. Journal of Shandong University (Philosophy and Social Sciences Edition), (4), 99-111.
4. Fang, X., & Hu, D. (2023). Corporate ESG performance and innovation: Evidence from A-share listed companies in China. Economic Research Journal, 58(2), 91-106.

5. Cai, Q., Chen, Y., & Lin, K. (2020). Credit availability and corporate innovation: Incentive or inhibition? Evidence from bank branch data and financial geographic structure. Economic Research Journal, 55(10), 124-140.
6. Chen, D., Sun, Y., & Wang, D. (2021). Relational network embedding, joint venture capital, and corporate innovation efficiency. Economic Research Journal, (11), 135-147.
7. Guo, Y. (2018). The signaling mechanism of government innovation subsidies and corporate innovation. China Industrial Economics, (9), 98-116.
8. Yu, Y., Zhao, Q., & Ju, X. (2018). Inventor executives and corporate innovation. China Industrial Economics, (3), 136-154. https://doi.org/10.19581/j.cnki.ciejournal.2018.03.008
9. Wang, B., & Yang, M. (2022). A study on the mechanism of ESG performance on corporate value: Empirical evidence from A-share listed companies in China. Soft Science, 36(6), 78-84.
10. Liu, Y., Pan, H., Li, Y., & He, Z. (2023). ESG performance, technological innovation, and value creation in manufacturing enterprises. Scientific Decision Making, (9), 23-36.
11. Xie, H., & Lyu, X. (2022). Responsible international investment: ESG and China's OFDI. Economic Research Journal, (3), 49-64.
12. Fang, X., & Na, J. (2020). Stock market reaction to green innovation: Evidence from GEM firms. Economic Research Journal, (10), 4-19.