

The Impact of ESG Performance on Corporate Innovation Performance: A Study Based on Listed Manufacturing Companies in China

Ting Huang *

Department of Nanjing University of Science and Technology, Nanjing, China

* Corresponding Author Email: 15251960295@163.com

Abstract. In recent years, with the increasing awareness of sustainable development, the environmental, social, and governance (ESG) performance of enterprises has gradually attracted widespread attention from investors and has had a continuous impact on the long-term operation of enterprises. Based on stakeholder theory and signal transmission theory, this paper analyzes the impact and mechanism of ESG performance on innovation in manufacturing enterprises. Using data from 2,380 A-share listed manufacturing companies from 2009 to 2024, the study finds that the improvement of ESG performance has a significant positive impact on innovation in manufacturing enterprises; and this promoting effect is more pronounced in enterprises with larger scale. Further mechanism analysis reveals that ESG performance primarily promotes innovation in manufacturing enterprises through mechanisms such as alleviating financing constraints, increasing attention from securities analysts, and increasing government subsidies.

Keywords: ESG, Corporate Innovation, Manufacturing.

1. Introduction

Manufacturing refers to the industry that utilizes natural resources, labor, and technology to transform raw materials into final products or semi-finished goods that can be used for production or consumption through physical or chemical processing. It encompasses multiple categories such as machinery, chemicals, pharmaceuticals, food, and equipment manufacturing. The manufacturing economy is vast and serves as a crucial support for China's real economy. According to data from the Ministry of Industry and Information Technology, China's manufacturing value added exceeded 33 trillion yuan in 2024, accounting for nearly 30% of the global total, maintaining its position as the world's largest manufacturing country for fifteen consecutive years. China's manufacturing industry boasts a complete industrial chain, covering multiple links such as research and development design, raw material supply, component manufacturing, and sales services. Its products are widely used in various sectors of the national economy and serve as a core force driving the deep integration of industrialization, informatization, and modernization.

However, China's manufacturing industry has long faced challenges related to its development approach and structural aspects. On the one hand, as a traditional high-energy consumption and high-pollution industry, manufacturing consumes a significant amount of energy resources, especially in heavy and chemical industries such as steel, building materials, and non-ferrous metals, where energy consumption and emission intensity are relatively high, and the process of green and low-carbon transformation lags behind. The environmental awareness and capabilities of relevant enterprises need to be further improved. On the other hand, the problem of overcapacity in traditional manufacturing industries is prominent, with severe homogenization competition in mid-to-low-end products. Meanwhile, high-end equipment, core components, key materials, and other fields still rely on imports, and the ability to innovate independently urgently needs to be enhanced.

Nature is the fundamental condition for human survival and development. However, in recent years, extreme weather events have become frequent, leading to a growing concern about global climate and ecological environment. With the development of the global economy, environmental benefits and social responsibility are gradually becoming important considerations for the sustainable development of enterprises. Against this backdrop, the Environmental, Social, and Governance (ESG)

scoring system has emerged as a key indicator for measuring corporate sustainability. The term "Environmental, Social, and Governance Investment (ESG)" originated from the 2004 report "Global Compact". According to the report, more than 20 large financial institutions around the world firmly believe that actively addressing ESG issues is crucial to the overall quality of corporate management.

Compared to traditional corporate evaluation criteria, ESG focuses on the non-financial performance of enterprises and is a key factor in measuring corporate sustainability. It aims to encourage enterprises to pay attention to and manage risks and opportunities related to the environment, society, and governance, in addition to pursuing economic benefits. Paying attention to ESG can help enterprises better manage issues and risks related to the environment, society, and governance, achieve sustainable development, and gain the trust and support of investors and other stakeholders.

Nowadays, sustainable development has become a global consensus, and China is also playing an indispensable role in promoting this goal. In 2015, General Secretary Xi Jinping first proposed the five development concepts, emphasizing the concept of green development. This is also the key policy guidance for China's ESG information disclosure, which embodies the ideas of environmental responsibility, social responsibility, and governance improvement. In 2017, General Secretary Xi Jinping made a statement on high-quality development in the report of the 19th CPC National Congress, striving to achieve sustainable development based on economic growth. The dual-carbon goals in 2020 have further influenced China's future green development strategy, drawing widespread attention from all sectors of society to green environment and green finance. It is necessary to enhance stakeholders' attention to the ESG information disclosure of relevant enterprises.

As the concept of green and sustainable development becomes deeply ingrained in people's minds, the "double high" characteristics of the manufacturing industry often damage corporate image and reputation, slow down the process of high-quality transformation, and hinder its long-term development. In the context of "dual carbon" goals, manufacturing enterprises must actively respond to the national call for sustainable development, actively engage in ESG practices, and release signals to the market that they adhere to green environmental protection concepts if they want to pursue better development.

Focusing on innovation and driving the manufacturing industry to a higher level of development is a major strategic task in China's current and future economic development. The "Outline of the National Medium- and Long-Term Plan for Science and Technology Development" in 2006 first clearly proposed the strategy of independent innovation, laying the foundation for a series of subsequent policies. Subsequently, the "Opinions on Deepening the Reform of the Science and Technology System and Accelerating the Construction of the National Innovation System" in 2012 emphasized the principal role of enterprises in scientific and technological innovation, promoting the close integration of science and technology with the economy, and initiating a systematic reform of the science and technology system. The Fourth Plenary Session of the 20th Central Committee of the Communist Party of China held in October 2025 proposed that we should seize the historical opportunity presented by the new round of technological revolution and industrial transformation, accelerate high-level scientific and technological self-reliance, and lead the development of new productive forces.

Currently, the manufacturing industry still faces issues such as a lack of innovative spirit, low levels of research and development investment, and insufficient momentum in talent cultivation. How Chinese manufacturing enterprises can utilize effective means to significantly enhance their independent innovation capabilities, gain market recognition, and achieve high-quality development is a major practical issue that requires joint consideration by the government, enterprises, and academia.

In light of this, this paper selects data from 2,380 A-share listed manufacturing enterprises spanning from 2009 to 2024 to examine the impact of ESG performance on the substantive innovation output of manufacturing enterprises. It also selects indicators of collaborative innovation for robustness testing, making the proxy variables for enterprise innovation more comprehensive.

Subsequently, it further investigates the mechanism by which ESG performance affects innovation output from three perspectives: financing constraints, securities analyst attention, and government subsidies. Finally, it conducts a heterogeneity analysis based on enterprise size, providing new ideas for effectively enhancing innovation capabilities while encouraging manufacturing enterprises to strive for sustainable development.

2. Theoretical Analysis and Research Hypothesis

2.1. Impact of ESG Performance on Corporate Innovation

In traditional economic theory, enterprises often pursue profit maximization as their goal, and corporate innovation, as a major means of spanning the enterprise lifecycle and obtaining excess economic profits, has garnered significant academic attention. However, the process is also embedded with high uncertainty, information asymmetry, and agency conflicts. This information asymmetry exists widely between investors and enterprises, as well as between managers and shareholders. Current ESG ratings and mandatory requirements for ESG information disclosure can provide important non-financial information. On the one hand, investors and financial institutions are unable to effectively supervise major shareholders or management, have a relatively low risk tolerance towards enterprises, and often prefer to invest in conventional projects with short investment cycles and low risks. On the other hand, managers, considering their own reputation or performance evaluations centered on short-term profits, generally tend to avoid risks, and lack sufficient incentives for innovative projects that contribute to the long-term development of the enterprise but carry greater risks.

The ESG (Environmental, Social, and Governance) concept provides a new perspective for breaking through this dilemma. As a reflection of a company's social contribution and sustainable development capabilities, good ESG performance signals to investors that the company actively fulfills its social responsibilities, offering effective decision-making references for investors. At the same time, the demand for sustainable development is increasingly reflected in the investment and consumption decisions of the general public. The pressure from environmental regulations imposed by the government and the public forces companies to eliminate existing high-energy consumption, high-pollution production technologies and outdated production capacities. Innovation is an important means to achieve this goal. In this process, companies with ESG advantages can also benefit from institutional tilting, including policies such as tax incentives and financial subsidies, which reduce the cost of innovation and enhance the level of innovation [1].

According to stakeholder theory, ESG practices fulfill environmental and social responsibilities and enhance corporate governance to meet the expectations of different interest groups towards enterprises. Good ESG performance can enhance employees' identification with corporate culture, inspire their professional enthusiasm, and encourage them to spontaneously engage in corporate innovation activities. It also enhances corporate reputation, attracts the attention of institutional investors, governments, and other stakeholders, and obtains policy support or capital investment from external entities, thereby promoting corporate innovation. When the ESG performance of manufacturing enterprises improves, it allows these stakeholders, especially the public, to fully understand the business strategy and development prospects of the enterprise. With positive interactions and subsequent effective communication between the two, a stable cooperative relationship is established [2], thereby gaining more trust and support from stakeholders and stimulating the innovation vitality of manufacturing enterprises. Therefore, this paper proposes the following hypothesis:

Hypothesis 1: The ESG performance of manufacturing enterprises has a positive effect on corporate innovation.

2.2. ESG performance, financing constraints, and corporate innovation

Historically, Chinese enterprises have faced significant financing constraints. To promote sustainable development, it is imperative to effectively alleviate these constraints and achieve efficient allocation of funds. One of the root causes of financing difficulties is information asymmetry. Due to the high risk, long payback period, and strong uncertainty of innovation investments in manufacturing enterprises, they usually require more stable sources of funding. However, the information asymmetry between enterprises and fund providers regarding innovation projects weakens the willingness of fund providers to lend. Based on signal transmission theory, good ESG performance demonstrates the enterprise's morality and responsibility towards society, establishes a positive corporate image, enhances investment confidence, helps enterprises attract more capital injections, and thereby alleviates financing pressure. At the same time, due to the inherent externalities of ESG construction, which require a certain cost, disclosing higher-quality financial information while engaging in ESG construction also sends a positive signal to the outside world that the enterprise's operating conditions are good. When enterprises face fewer financing constraints, they can often obtain sufficient capital at lower financing costs, prompting enterprises to allocate resources to areas more conducive to their growth and development, and promoting corporate innovation. Therefore, this paper proposes the following hypothesis:

Hypothesis 2: Good ESG performance of manufacturing enterprises promotes corporate innovation by alleviating financing constraints.

2.3. ESG performance, securities analysts' attention, and corporate innovation

As the concept of sustainable development becomes more popular, securities analysts will fully consider policy tendencies and corporate social responsibility performance when evaluating investment opportunities. However, due to information asymmetry, securities analysts find it difficult to fully understand relevant information about enterprises and can only rely on various signals in the market to assist in decision-making. Corporate ESG (Environmental, Social, and Governance) information disclosure stands as one of the most crucial signals. Enterprises that actively embrace ESG responsibilities often garner more attention from securities analysts [3] and receive recommendations to increase holdings from investors. Consequently, these favored enterprises attract more capital inflows, accumulating substantial funds for innovation. Simultaneously, analysts serve as a significant regulatory force in the capital market, partially substituting auditors in their external governance and supervisory roles [4]. This helps alleviate the degree of information asymmetry between shareholders and corporate management, thereby urging enterprises to allocate resources towards activities that promote sustainable development, such as research and development (R&D) and innovation. Therefore, this paper proposes the following hypothesis:

Hypothesis 3: Good ESG performance of manufacturing enterprises promotes corporate innovation by increasing securities analysts' attention.

2.4. ESG performance, government subsidies, and corporate innovation

In the context of the "dual carbon" goals, the concept of sustainable green development is highly advocated. In recent years, the central government has placed the construction of ecological civilization and sound social governance in a prominent position in overall work. The promotion incentives for local officials have gradually shifted from emphasizing "GDP-only" economic construction to highlighting "comprehensive incentives" for pollution control, social governance, and sustainable development. Enterprises with good ESG performance are often more willing to undertake environmental and social responsibilities, consciously engaging in activities such as targeted poverty alleviation, charitable donations, and environmental protection, sending positive signals to the government about their fulfillment of social responsibilities. At the same time, these behaviors align with the local government's performance goals, facilitating enterprises to obtain financial subsidies, tax incentives, and financing rights from the government [5].

Furthermore, government subsidies contribute to promoting corporate innovation. Firstly, government subsidies can not only effectively reduce the R&D risks faced by enterprises but also alleviate their financing constraints, endowing managers with more resources and confidence to engage in long-term and high-investment in-depth R&D, thereby enhancing corporate innovation performance [6]. Secondly, corporate executives often hesitate to invest due to the uncertainty of innovation investment, while government subsidies can provide "timely assistance" through the innovation compensation mechanism [7] in case of corporate innovation failures. The intervention of subsidy funds will provide new resources and impetus for enterprises to carry out additional and novel innovation activities. This alleviates enterprises' concerns about "sunk costs" to a certain extent, boosts morale, and ignites their enthusiasm for innovation. Simultaneously, government subsidies symbolize government recognition and support. Based on the stakeholder theory, stakeholders usually regard government subsidies as recognition of the target enterprise, thus they are more inclined to establish cooperative relationships with it [8]. This undoubtedly enhances the external financing capabilities of enterprises effectively, while also attracting the support of key stakeholders such as supply chain partners and high-end technical talents. To a certain extent, it brings new knowledge input to enterprises and ultimately has a positive impact on their exploitative and exploratory innovation activities [9]. Therefore, this paper proposes the following hypothesis:

Hypothesis 4: Good ESG performance of manufacturing enterprises promotes enterprise innovation by increasing government subsidies.

3. Sample Selection and Research Design

3.1. Sample Selection and Data Sources

This paper selects data from A-share listed manufacturing companies from 2009 to 2024 as the research sample for research and analysis. ESG data comes from the Wind database, corporate innovation data comes from the CNRDS database, and control variables all come from the CSMAR database.

To ensure the rationality and effectiveness of the data, as well as the authenticity and reliability of the regression results, the panel data selected as samples in this paper underwent the following processing: (1) ST sample companies were excluded; (2) companies in the financial industry were excluded; (3) samples with missing data were excluded; (4) the selected variables were subjected to 1% and 99% winsorization. After the processing, a total of 24,306 observations were ultimately obtained.

3.2. Variable Definition

3.2.1. The definition of ESG Performance (ESG)

Following the practice in relevant literature, this paper measures the ESG performance of sample enterprises based on the Huazheng ESG evaluation system. The nine levels in the Huazheng ESG evaluation are assigned different scores ranging from 9 to 1, from high to low, with higher scores indicating better ESG performance. This quantifies qualitative indicators and provides a means for sustainable evaluation of corporate ESG performance.

3.2.2. The definition of corporate innovation (Patent)

Referring to Li Wenjing and Zheng Manni (2016) [10], it is believed that only an increase in invention patent applications can enhance the market value of a company, which is classified as "substantive innovation" that drives technological progress and gains competitive advantage. Therefore, this paper chooses the natural logarithm of the number of invention patents ultimately granted plus one (Patent) as the measurement indicator of corporate innovation benefits.

3.2.3. Control variables

Control variables are drawn from relevant scholarly literature by Cai Qingfeng et al. (2020) [11] and Tsang et al. (2021) [12]. To enhance the reliability and accuracy of the research, this paper incorporates variables that can affect the level of corporate innovation as control variables in the model. Financial indicators at the individual enterprise level are introduced: log-transformed enterprise age (Age), ownership concentration (Big1), cash holdings (Cash), duality of the roles of chairman and CEO (Duality), whether there is concurrent appointment of chairman and general manager, proportion of fixed assets (Fix Ratio), enterprise growth rate (Growth), proportion of independent directors (Independent Director), leverage ratio (Leverage), proportion of executive shareholding (Manager Holding), book-to-market ratio (MTB), profitability (ROA), enterprise size (Size), and property rights attribute (SOE).

3.3. empirical model

To examine the impact of ESG performance on corporate innovation level, this paper constructs the following empirical model:

$$\text{Patent}_{i,t+2} = \beta_0 + \beta_1 \text{ESG}_{i,t} + \beta_2 \text{Control}_{i,t} + \mu_i + \text{YEAR} + \varepsilon_{i,t} \quad (1)$$

Among them, subscripts i and t represent the sample individual and year, respectively. The dependent variables Invent and Patent represent the innovation level of company i in period $t+2$. The core explanatory variable ESG performance is quantified as a proxy variable using the ESG score of the sample company. $\text{Control}_{i,t}$ is a series of control variables mentioned above. To control the impact of factors such as industry and macroeconomic conditions on corporate innovation level, this paper also controls for individual (μ_i) and year (YEAR) fixed effects. ε represents the random error term. The parameter β_1 reflects the specific effect of ESG performance on corporate innovation level, with its sign indicating the direction of impact, and its specific numerical value and significance representing the degree of impact, which are key focuses in the research. To effectively address the lagged impact of ESG on corporate innovation and the endogeneity caused by reverse causality, this paper chooses to precede the dependent variables by two periods.

4. Empirical Research and Result Analysis

4.1. Descriptive Statistical Analysis

Table 1 presents the descriptive statistical results of the variables in this study, including minimum, maximum, mean, and standard deviation. As shown in Table 1, the total sample data for this paper comprises 24,306 observations, with the minimum value of the measurement indicator for corporate innovation level being 0, which is consistent with the actual situation. It can also be observed that there is significant variability in the innovation levels within the selected sample of A-share listed manufacturing companies. The average ESG performance is 4.137, indicating that at the current stage, the overall ESG performance of China's A-share listed companies is still at a relatively low level, with considerable room for development and improvement. Furthermore, the maximum and minimum values of 9 and 1, respectively, reveal substantial differences in the performance of individual companies, with uneven levels. The other variables are all within a relatively reasonable range, and will not be elaborated further here. In summary, the standard deviations of all listed variables are within the normal and acceptable range, indicating that the data has been cleaned of extreme outliers, making the subsequent regression results more valid.

Table 1. Descriptive Statistics

Variable	Obs	mean	Std. Dev.	Mini	Max
esg	24306	4.137	1.072	1	9
patent	24306	1.648	1.337	0	5.74
cash	24306	0.177	0.136	0.012	0.665
age	24306	2.929	0.337	1.946	3.611
top1	24306	0.328	0.139	0.086	0.7
dual	24306	0.343	0.475	0	1
fixratio	24306	0.206	0.127	0.011	0.598
growth	24306	0.149	0.347	-0.516	2.037
indep	24306	0.385	0.074	0.25	0.6
lev	24306	0.382	0.198	0.049	0.906
mshare	24306	0.178	0.213	0	0.718
mtb	24306	0.739	0.614	0.089	3.531
roa	24306	0.045	0.069	-0.229	0.238
size	24306	21.962	1.15	19.78	25.52
soe	24306	0.252	0.434	0	1

4.2. Baseline Regression

This paper employs a two-way fixed effects model considering both industry and year to examine the impact of ESG performance on the innovation performance of manufacturing enterprises. The results are presented in Table 2. As indicated in columns (1) and (2), when control variables are not included or industry-year fixed effects are not controlled, the impact coefficients of ESG performance on enterprise innovation performance are 0.044 and 0.023, respectively, both of which are significant at the 1% level. Furthermore, as shown in column (3), the ESG coefficient is 0.027, which remains significant at the 1% level. This provides ample empirical evidence for Hypothesis 1 of this paper, suggesting that an improvement in ESG rating of manufacturing enterprises will promote the enhancement of their innovation performance.

Table 2. Baseline regression

	(1)	(2)	(3)
	patent	patent	patent
esg	0.044***	0.023***	0.027***
	(0.007)	(0.007)	(0.009)
cash		0.179***	-0.022
		(0.068)	(0.100)
age		0.881***	-0.052
		(0.046)	(0.193)
top1		0.196*	0.149
		(0.107)	(0.195)
dual		0.066***	0.070**
		(0.020)	(0.030)
fixratio		0.232**	0.065
		(0.090)	(0.126)
growth		-0.051***	0.001
		(0.018)	(0.001)
indep		0.104	-0.088
		(0.097)	(0.105)
lev		0.177***	0.036**
		(0.065)	(0.014)
mshare		0.026	-0.001***
		(0.077)	(0.000)
mtb		-0.000***	-0.000
		(0.000)	(0.000)
roa		0.032	0.037
		(0.130)	(0.032)
size		0.499***	0.463***
		(0.016)	(0.028)
soe		0.067*	-0.009
		(0.038)	(0.061)
constant	0.623***	-11.986***	-9.031***
	(0.192)	(0.298)	(0.807)
industry	YES	NO	YES
year	YES	NO	YES
N	18743	18743	18743
r2	0.239	0.236	0.288

4.3. Mechanism Test

This paper refers to Fang Xianming and Hu Ding (2023) and adopts the ratio of corporate financial expenses to total liabilities (Interest) as a measure of financing constraints to analyze the impact of ESG on corporate financing constraints. Column (2) of Table 3 reveals a significant negative correlation between ESG performance and financing constraints (Interest), with a regression coefficient of -0.016, which is significant at the 1% statistical level, indicating that good ESG performance of enterprises helps alleviate the financing constraints they face.

The third column in the table reflects the mediating effect of financing constraints (interest) in the process where ESG performance influences corporate innovation performance. The data indicates that the coefficient of financing constraints (interest) is -0.036, and it is significantly negative at the 1% statistical level, revealing a negative correlation between financing constraints and corporate innovation performance. Simultaneously, the coefficient of ESG performance is positive at the 1% significance level, suggesting that the positive effect of ESG performance on corporate innovation performance is achieved through the mediating mechanism of alleviating financing constraints. That

is, investors tend to invest more in companies with excellent ESG performance, thereby reducing their financing constraints and enhancing corporate innovation performance, thus verifying Hypothesis 2.

Table 3. Mechanism Test: Financing Constraints Mechanism

	(1)	(2)	(3)
	Patent	interest	Patent
esg	0.027*** (0.009)	-0.016*** (0.004)	0.034*** (0.007)
interest			-0.036*** (0.011)
constant	-9.031*** (0.807)	-0.118 (0.259)	-11.110*** (0.300)
controls	YES	YES	YES
industry	YES	YES	YES
year	YES	YES	YES
N	18743	23785	18493
r2	0.288	0.100	0.422

Column (2) in Table 4 reveals the impact of ESG performance on analyst attention, where the regression coefficient of ESG is 0.305 and is significant at the 1% significance level, indicating that optimizing corporate ESG performance can effectively enhance analyst attention. Column (3) in the table demonstrates the mediating effect of analyst attention (Analyst) in the process of ESG performance affecting corporate innovation performance. The results show that the coefficients of analyst are all positively significant, highlighting the positive correlation between analyst attention and corporate innovation performance, meaning that an increase in analyst attention helps enhance corporate innovation performance. At the same time, the coefficient of ESG performance is also positive at the 1% significance level, indicating that the positive effect of ESG performance on corporate innovation performance is achieved through the mediating path of enhanced analyst attention. Hypothesis 3 is proven.

Table 4. Mechanism Test: Analyst Attention Mechanism

	(1)	(2)	(3)
	Patent	analyst	Patent
esg	0.027*** (0.009)	0.305*** (0.044)	0.022*** (0.007)
analyst			0.002** (0.001)
constant	-9.031*** (0.807)	-88.043*** (8.146)	-8.832*** (0.469)
controls	YES	YES	YES
industry	YES	YES	YES
year	YES	YES	YES
N	18743	24306	18743
r2	0.288	0.130	0.166

Column (2) in Table 5 reveals the impact of ESG performance on government subsidies, where the regression coefficient of ESG is 0.025 and is significant at the 1% significance level, indicating that the improvement of corporate ESG performance helps increase government subsidies. Column (3) in the table reveals the mediating effect of government subsidies (Sub) in the process of ESG performance affecting corporate innovation performance. The results show that the coefficient of Sub is significantly positive at the 1% level, indicating that government subsidies are positively correlated with corporate innovation performance, and as the government subsidies received by enterprises increase, innovation performance also increases. At the same time, the coefficient of ESG

performance is also significantly positive, indicating that the promoting effect of ESG performance on corporate innovation performance is achieved through the mediating path of increasing government subsidies. Hypothesis 4 is proven.

Table 5. Mechanism Test: Government Subsidy Mechanism

	(1)	(2)	(3)
	Patent	sub	Patent
esg	0.027*** (0.009)	0.025*** (0.007)	0.023*** (0.007)
sub			0.049*** (0.007)
constant	-9.031*** (0.807)	-4.143*** (1.226)	-8.901*** (0.471)
controls	YES	YES	YES
industry	YES	YES	YES
year	YES	YES	YES
N	18743	23530	18078
r2	0.288	0.233	0.160

4.4. Endogeneity issue

The baseline regression will precede the dependent variable by two periods, which can solve the endogeneity caused by reverse causality to some extent. To further address the potential endogeneity issues in the model, this paper attempts to construct instrumental variables. Referring to the approach of Shen Zhe and Zhang Kunpeng (2024), the mean ESG rating of other enterprises in the same industry and year (*esg_average*) is selected as the instrumental variable. Since there are inevitably commonalities between companies in the same industry, the ESG performance of individual enterprises as the explanatory variable is also necessarily correlated with the ESG performance of other enterprises in the same industry and year, which meets the requirement that the instrumental variable must be correlated with the explanatory variable. At the same time, the mean ESG performance of other companies in the same industry as the individual company in the same year does not directly affect the company's innovation performance, which also meets the requirement that the instrumental variable must be exogenous.

The first-stage model of instrumental variable regression is:

$$ESG_{i,t} = \beta_0 + \beta_1 ESG_average_{i,t} + \beta_2 Control_{i,t} + INDUSTRY + YEAR + \varepsilon_{i,t} \quad (2)$$

Among them, $ESG_{i,t}$ represents the ESG rating of listed company i in year t , while $ESG_average_{i,t}$ denotes the average ESG rating of other companies in the same industry as listed company i in year t . The remaining variables are the same as in model (1). In the second stage of the instrumental variable regression, the fitted value of the ESG rating is used as the dependent variable to estimate model (1). Table 6 presents the results of the two-stage instrumental variable regression. Like the approach in the benchmark regression, the enterprise invention patent grants are lagged by two periods to avoid the lag effect of ESG on enterprise innovation. Column (1) of Table 6 shows the results of the first-stage regression, with a significant positive coefficient, which also confirms the correlation of the instrumental variables. The Cragg-Donald Wald F statistic indicates the absence of issues such as weak instrumental variables and over-identification. Columns (2) of Table 4-6 shows that the regression results in the second stage are consistent with the benchmark results, thus suggesting that an improvement in ESG rating can promote the enhancement of enterprise innovation capability.

Table 6. Endogeneity test

	(1)	(2)
	esg	patent
esg		0.452**
		(0.179)
esg average	0.091***	
	(0.028)	
Cragg-Donald Wald F	100.554	
controls	YES	YES
industry	YES	YES
year	YES	YES
N	23723	18290
r2	0.060	0.375

4.5. Robustness Test

In the benchmark regression, the dependent variable is the number of patents obtained by listed companies after independent applications. To verify the possibility that ESG performance can enhance the resource integration capabilities of manufacturing enterprises, enabling them to jointly innovate by integrating internal and external resources, this paper uses the number of patents jointly applied for by listed companies as an alternative dependent variable for further regression analysis. As can be seen from columns (1) and (2) of Table 7, the coefficient of ESG remains significantly positive at the 1% level without the inclusion of control variables or industry-year fixed effects. The overall regression results are consistent with the benchmark regression, further validating Hypothesis 1.

Table 7. Robustness tests alternative variable.

	(1)	(2)	(3)
	jointinvent	jointinvent	jointinvent
esg	0.725***	0.488***	0.464***
	(0.159)	(0.155)	(0.157)
		(0.988)	(1.023)
constant	-12.457	-85.693***	-59.229**
	(24.241)	(9.640)	(27.361)
controls	NO	YES	YES
industry	YES	NO	YES
year	YES	NO	YES
N	18743	18743	18743
r2	0.082	0.236	0.099

4.6. Heterogeneity Test

Firm Size Firm size has an impact on both ESG performance and innovation performance. Large firms typically have advantages in resources, talent and technology reserves, and management structure, which drive their more positive ESG performance. Although small and medium-sized enterprises (SMEs) have a higher willingness to innovate, they are more likely to be constrained by issues such as difficult and expensive financing compared to large firms, resulting in insufficient overall R&D investment. At the same time, small businesses have less influence in the market, and their ESG performance has limited appeal to consumers and investors, unable to significantly boost sales or stock prices. Large firms have a larger market share and stronger brand influence, and good ESG performance can significantly attract investors and customers, leading to more capital inflows for innovation and development. Based on the median firm size of the manufacturing sample, this paper divides firms into large and small groups for regression analysis. As can be seen from Table 8,

the ESG performance coefficient for large firms is positive and significant at the 1% level. In contrast, for small firms, although the ESG performance coefficient is significant, its sign is opposite. Therefore, it can be concluded that as firm size increases, the promotional effect of ESG on corporate innovation capability becomes more pronounced.

Table 8. Heterogeneity test of enterprise size

	(1)	(2)
	Large firms	Small firms
	patent	Patent
esg	0.039***	-0.029**
	(0.011)	(0.011)
constant	-8.880***	-6.614***
	(0.811)	(1.158)
controls	YES	YES
industry	YES	YES
year	YES	YES
N	8961	7633
r2	0.305	0.158

5. Summary

5.1. Research Conclusion

Based on the signaling theory, stakeholder theory, and information asymmetry theory, this paper constructs a regression model to examine the effect of ESG performance on corporate innovation performance in manufacturing enterprises, and further explores whether the relationship between the two variables is realized through mechanisms such as alleviating financing constraints, enhancing the attention of securities analysts, and increasing government subsidies. Firstly, through theoretical analysis, this paper proposes four research hypotheses. Subsequently, in the research design phase, based on relevant literature, measurement indicators for ESG performance, corporate innovation performance, and various control variables and mechanism variables are determined. When conducting empirical testing, this paper selects A-share listed manufacturing companies from 2009 to 2024 as research samples, models them, and then performs empirical processing and analysis. The conclusions are as follows:

(1) There is a significant positive correlation between ESG performance and corporate innovation performance in manufacturing enterprises, that is, companies with better ESG performance have more impressive innovation performance.

(2) In the examination of the effects of mechanism variables, the feasibility of three transmission paths has been demonstrated: "corporate ESG performance - financing constraints - innovation performance", "corporate ESG performance - attention from securities analysts - innovation performance", and "corporate ESG performance - government subsidies - innovation performance".

(3) This paper also conducted a heterogeneity test by grouping enterprises based on their size. The results indicate that compared to the other two groups, the larger sample group and the sample group not audited by the Big Four have stronger promotional effects of ESG performance on corporate innovation performance.

Finally, to further ensure the validity of the regression results and conclusions drawn, this paper selects instrumental variables to conduct an endogeneity test on the regression results. Additionally, it replaces the measurement method of corporate innovation performance as the dependent variable for robustness testing and adjusts the sample interval for regression analysis. The final conclusions all support Hypothesis 1, indicating that good ESG performance of manufacturing enterprises positively improves and promotes corporate innovation performance.

5.2. Policy Suggestions

5.2.1. At the Corporate Level

In recent years, as the concept of sustainable development has gradually gained popularity, corporate ESG investment behavior has also become a focal point for investors. Considering the research findings presented in this paper, good corporate ESG performance positively promotes corporate innovation performance. This not only aids companies in integrating internal and external resources and responding to the growing public demand for sustainable development, but also fosters a tolerant innovation environment and meets the needs for high-quality corporate development. Firstly, corporate management should embody the ESG concept in daily operations from the three dimensions of ESG, achieving sustainable development for the company. Especially for large listed companies, due to their inherent characteristics, optimizing ESG performance can better leverage its promotional effect on corporate innovation. Secondly, from the perspective of long-term corporate development, innovation projects are characterized by long investment cycles, high risks, and uncertainties. Stakeholders have a lower level of risk tolerance and prefer traditional investment projects. Corporate managers should leverage a positive corporate culture to fully stimulate the innovation enthusiasm of core employees and build a good social image to win the trust of stakeholders and enhance their willingness to bear risks.

5.2.2. At the government level

Currently, the issues of difficult and expensive financing are prevalent for both small and medium-sized enterprises (SMEs) and large enterprises. To address the financing constraints faced by enterprises and further unleash their innovation vitality, local governments can provide appropriate policy support. In the form of fiscal subsidies, they can assist enterprises in obtaining essential resources for innovation such as funds and talents, guide enterprises to internalize their social responsibility advantages into innovation advantages, and promote "incremental improvement and quality enhancement" in enterprise innovation. Specific measures include guiding financial institutions to offer policy benefits to enterprises with ESG advantages, providing more financial support for the issuance of green bonds and sustainable bonds. At the same time, appropriate tax relief can be implemented for green enterprises with an innovation orientation, reducing labor costs for green enterprises, accelerating the accumulation of human capital, and transforming green advantages into talent advantages. The goal is to create a new ecosystem for capital market development, enhance enterprises' risk tolerance, and boost their willingness to innovate.

References

- [1] Ma Wenjie, Hu Yue. Regional Carbon Peaking Pressure and Corporate Green Technological Innovation: A Study Based on Carbon Emission Growth Rate [J]. *Accounting and Economic Research*, 2022, 36 (04): 53 - 73.
- [2] Yi Lingxue, Jiang Yichi, Yao Shujie. Research on the Value Creation Effect of Corporate ESG Practices: An Examination from the Perspective of External Pressure [J]. *Nanfeng Economic Review*, 2022, (10): 93 - 110.
- [3] Jiang Yichi, Yao Shujie. ESG Information Disclosure, External Attention, and Corporate Risk [J]. *Journal of Systems Management*, 2024, 33 (01): 214 - 229.
- [4] Li Xiaoling, Ren Yu. Securities Analyst Attention and Audit Oversight: Substitution or Complementary Effect? - Empirical Evidence from Private Listed Companies in China [J]. *Journal of Audit and Economics*, 2013, 28 (06): 20 - 28.
- [5] Wang Zhi, Peng Baichuan. The Impact of Corporate ESG Performance on Innovation Performance [J]. *Statistics and Decision*, 2022, 38 (24): 164 - 168.
- [6] Gao Hongli, Li, Chen Jinghan, et al. Does Government R&D Support Affect External Financing of High-Tech Enterprises? An Explanation Based on Organizational Legitimacy Theory [J]. *Nankai Management Review*, 2017, 20 (06): 178 - 189.

- [7] Zhang Bochen, Zhao Shukuan. Research on the Impact of Government Subsidies on Corporate Green Innovation: The Moderating Effects of Political Connections and Environmental Regulations [J]. *Scientific Research Management*, 2022, 43 (11): 154 - 162.
- [8] Wang Baozhong, Zhang Xiang. Auxiliary Vehicles Depend on Each Other: A Study on the Impact of ESG Practice on Corporate Innovation [J]. *Journal of Xi'an University of Technology*, 2024, 40(03): 315-324+450.
- [9] Liu Zhiying, Ye Yuhang, Zheng Weiwei. Gradual Progress or Instant Success? A Study on the Impact of Government Subsidy Pace on Corporate Dual Innovation [J]. *Technological Economics*, 2023, 42 (05): 56 - 67.
- [10] Li Wenjing, Zheng Manni. Substantive Innovation or Strategic Innovation? - The Impact of Macro-level Industrial Policies on Micro-level Enterprise Innovation [J]. *Economic Research Journal*, 2016, 51 (04): 60 - 73.
- [11] Cai Qingfeng, Chen Yihui, Lin Kun. Accessibility of credit resources and corporate innovation: incentive or inhibition? - Micro-evidence based on bank branch data and financial geographical structure [J]. *Economic Research*, 2020, 55 (10): 124 - 140.
- [12] Tsang A, Frost T, Cao H. Environmental, Social, and Governance (ESG) disclosure: A literature review [J]. *The British Accounting Review*, 2023, 55 (1).
- [13] Qi Jiangna, Chen Huilin, Zhang Yang. Firm Size, Brand, Price, and Audit Quality: A Study on Fees and Quality in the Chinese Audit Market of the International "Big Four" Firms [J]. *Audit Research*, 2004, (03): 59 - 65.