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Article

Impact of Green Innovation Quality on Performance of Manufacturing Enterprise

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Abstract: Environmental pollution caused by the rapid development of China's economy makes the green transition extremely urgent. Compared with others, the manufacturing industry in China is more dependent on environmental resources with more resource consumption. Therefore, manufacturing enterprises must endeavor to protect the environment through green technology innovation and achieve sustainable development through efficient and innovative research and development. Based on the definition of green innovation quality and performance, the impact of green innovation quality on the performance of enterprises was explored in this study. The data of the listed manufacturing enterprises from 2011 to 2021 were analyzed to construct a regression model and explore the relationship between green innovation quality and enterprise performance. Improving the green innovation quality of the enterprise significantly improves its performance, especially for newer ones with a large scale, a low asset-liability ratio, small financing constraints, and a high-profit margin. The improvement of green innovation quality in state-owned enterprises more significantly impacts corporate performance than private enterprises. Policy suggestions were made based on the results of this study to improve the quality of green innovation in the manufacturing industry.

Keywords: Green innovation quality, Manufacturing enterprise, Corporate performance

1. Introduction

The demand for a low-carbon economy is increasing globally. At present, China is pursuing "carbon peak, carbon neutrality", which is a major development strategy and the requirement for high-quality development. Green transition is deployed strategically to promote the rejuvenation of China's economy. The "Dual Carbon" goal is essential for a broad and far-reaching social change, in which carbon reduction, pollution reduction, and green expansion and growth are mandatory. In the low-carbon economy, the Chinese government has issued a series of environmental planning policies for green development and transition. This highlights the strict standards and requirements for emissions from heavily polluting enterprises, and enterprises using traditional production and profit models have to adapt to the current environmental policy. For the manufacturing enterprise, it is necessary to upgrade the existing production technology that causes pollution and emissions to the environment and balance between today's environment and economic development.

The manufacturing industry is the main consumer of energy consumption and the major source of pollution emissions. At present, the energy consumption of China's manufacturing industry accounts for about 60% of the total energy consumption, and their carbon dioxide emission accounts for 50% of the total emission in China. Therefore, the green transition of the manufacturing industry is essential to achieve the "dual carbon" goal and high-quality development. In today's integrated economy, sustainable development with stable economic growth can be achieved by green innovation which improves creativity and scientific research level to obtain competitiveness in the market. At the same time, the government has introduced green development policies to encourage enterprises to change their current development model toward green innovation. Although the innovation for green technology in the short term may increase cost, it effectively protects the environment and promotes economic growth to achieve sustainable development in the long run, which is beneficial for enterprises.

The Chinese government put forward the five development concepts of "innovation, coordination, green, open, and sharing" and the concept of green development as an important guiding ideology. This shows the direction for enterprises and what to do for ecological protection and green innovation. Most manufacturing enterprises are involved in heavy pollution and high energy consumption. Thus, green innovation, social responsibility for environmental protection, and sustainable development with their performance sustained are the problems for manufacturing enterprises to solve. Therefore, based on the current green innovation quality and performance of manufacturing enterprises, it is mandatory to study the impact of green innovation quality on enterprise

performance and increase their awareness of environmental protection. A correlation between green innovation and the performance of manufacturing enterprises was also explored to promote their performance development and raise concerns about social responsibility. Based on the results, manufacturing enterprises can fulfill their social and environmental responsibilities, while increasing green innovation and promoting green production. The responsibility of manufacturing enterprises in environmental protection can be also promoted by standardizing enterprise management efficiently.

2. Literature Review

With the gradual increase of China's attention to the development of the green economy, there have been many studies on green innovation. The existing research mainly focused on green innovation, and the definition and measurement of green innovation quality are relatively few. The enterprise's green innovation is represented by the number of related patents (Hu et al., 2020). Wang *et al*. (2023) defined green innovation quality as the core index of innovation quality based on green invention patents. Feng et al. (2023) defined the quality of enterprise green innovation as the comprehensive embodiment of the ability, complexity, value, and economic performance of enterprise green innovation activities in terms of process and result, which is a standard to measure the output level and quality of enterprise green innovation, and reflects an important factor for enterprises to acquire new value and core competitiveness.

Based on the studies on the quality of green innovation, the quality of green innovation is defined as the core index of innovation quality with green invention patents in this study. At present, the quality of green innovation is measured using relevant information on the patents that reflect the effectiveness of innovation efforts, while R&D expenditure is regarded as an input of innovation but does not reflect the quality of innovation (Liu & Qiu, 2016). Because there is relatively little information about green patents, an index system has not been built to measure the quality. Instead, representative indicators such as the number of green patents are used to measure the quality of green innovation. Liao *et al*. (2023) and Zhou (2023) used the number of green invention patent applications of enterprises to represent the quality of green innovation. Yang and Sun (2024) measured the green innovation quality of enterprises by using the proportion of the number of green invention patent applications in the total number of patents applied by enterprises. For example, Feng *et al*. (2023) used the number of citations of green invention patents as an index to measure the green innovation quality of enterprises.

Due to different research fields and perspectives, a unified definition of enterprise performance has not yet been made. Zhao et al. (2015) pointed out that enterprise performance reflects the profit level obtained from daily production activities of enterprises. Therefore, a net interest rate on equity is chosen as an indicator to measure the profitability of enterprises, and the growth rate of operating income is selected to represent the growth of enterprises. Cheng and Bu (2002) defined enterprise performance evaluation as the process of the evaluation of capital operation and financial benefits. They thought enterprise performance was the core element of effective management and internal control. Enterprise performance is also defined as the operating profits created by enterprises through their business activities and the operating results in a specific business range. This view considers the contribution of enterprise managers to the operation, growth, and development of enterprises in the process of production and operation and the operation management level of enterprise managers.

The performance of entrepreneurial enterprises is evaluated with different methods and indicators. A performance evaluation index system is established to evaluate enterprise performance. A series of performance evaluation indicators are summarized from interview results from the perspectives of financial evaluation indicators, customer evaluation indicators, internal management evaluation indicators, and employee evaluation indicators (Shen and Luo, 2006). The balanced scorecard is adopted to measure the performance of enterprises by combining the financial and non-financial indicators. The influence of service innovation on enterprise performance can be objectively evaluated (Jiang and Li, 2015). The newly emerged Environment, Society, and Governance (ESG) rating system is adopted to evaluate the performance of enterprises with indicators for each element of Environment, Society, and Governance. The evaluation methods have been developed recently in China, and China Securities ESG rating, Shangdao Ronglv ESG rating, and Runling ESG rating are used widely.

As an authoritative method, China Securities ESG rating has been established 14 secondary indicators and 26 tertiary indicators for A-share listed companies by using a historical tracing method. Referring to the studies of Long and Zhang (2023) and Ren (2022), the ESG rating of China Securities was employed in this study. At present, the academic community does not have a relatively accurate definition of ESG, and there are certain limitations in choosing the ESG rating data of China Securities as the measurement standard in this paper. With the increasing global environmental concerns and the urgent need for sustainable development, more enterprises are paying attention to green innovation to reduce environmental impact and enhance the sustainable competitiveness of enterprises. In past studies, the relationship between green innovation quality and enterprise performance was reviewed from different perspectives. It was believed that the improvement of green innovation quality promotes enterprise performance. From the perspective of direct benefits, Wang et al. (2021) pointed out that improving the quality of green innovation

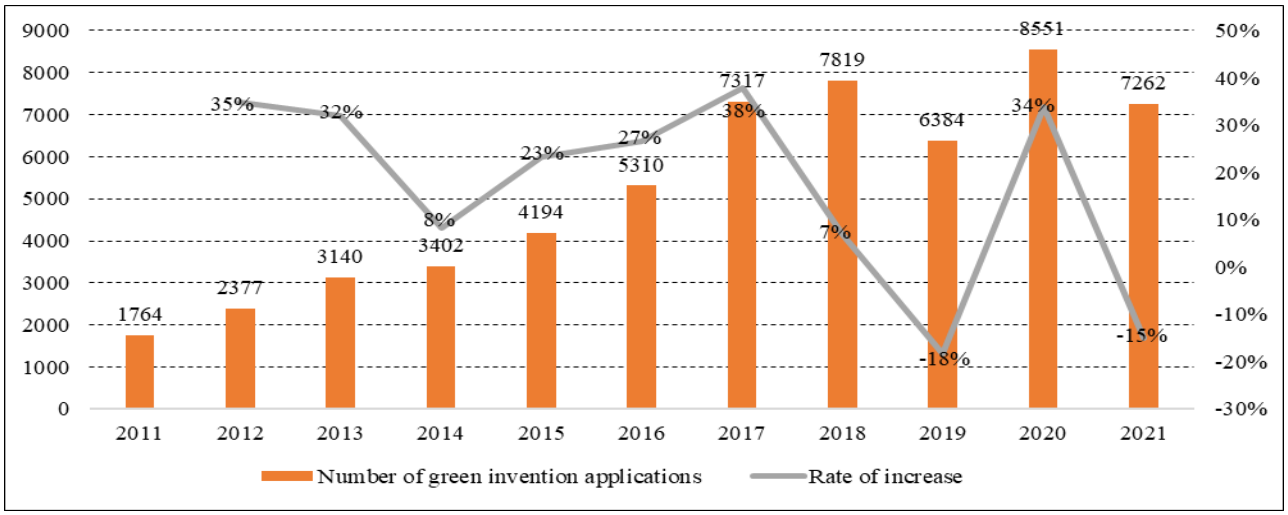
can improve the operation of enterprises and resource utilization efficiency and reduce production environmental costs. From the perspective of indirect benefits, Xie et al. (2019) found that enterprises with higher quality of green innovation have competitive advantages in the market, lower production costs, higher product quality, lower environmental pollution, and better enterprise which improves their performance. Jia and Zhang (2023) believed that green innovation optimizes resource allocation, reduces environmental pollution, and allows for social responsibility, thus enhancing the reputation of enterprises in society. From the perspective of competitiveness, Li and Xu (2017) pointed out that in a highly competitive environment, enterprises can promote green cooperation with suppliers by improving their green innovation quality and implementing internal green practices. Wang et al. (2023) believed that the combination of green innovation ability is the key to the growth of enterprises, competitiveness, the quality of green innovation, and the improvement of enterprises' sustainable development. From the perspective of enterprise nature, Chen and Zheng (2022) pointed out that green innovation impacts the performance of state-owned enterprises more than non-state-owned enterprises. Wei and Li (2023) also pointed out that the improvement of green innovation quality significantly improves the financial performance of state-owned enterprises, but has no significant impact on non-state-owned enterprises. Based on this, in this study, it was assumed that the quality of green innovation in manufacturing enterprises promotes the performance of enterprises.

Research on green innovation and the relationship between green innovation quality and enterprise performance is substantial. The impact of different enterprise natures was investigated from the perspective of benefits. The improvement of green innovation quality of enterprises improves their operation and performance. Therefore, it was explored if the improvement of green innovation quality in the manufacturing industry positively affects their performance. Based on the definition of green innovation quality, the number of green invention patent applications was used to measure the green innovation quality. The performance score of the ESG rating of China Securities was employed to measure the performance of enterprises.

3. Green Innovation Quality and Performance of Manufacturing Enterprises

3.1. Green Innovation Quality

The number of patent applications related to green invention shows the degree of innovation and technology. Thus, it was used to measure the green innovation quality of enterprises in this study. Figure 1 shows the number of green patent invention applications in the manufacturing industry from 2011 to 2021. The lowest number was 1,764 in 2011, and the highest one was 8,551 in 2020. The number increased rapidly. From 2011 to 2014, the number was small but increased every year. Since 2015, after the new development concept was put forward at the Fifth Plenary Session of the 18th CPC Central Committee, the number of patent applications continued to increase significantly. From 2019 to 2021, the growth rate decreased, which was caused by the overall decline in the number of research projects amid the COVID-19 pandemic.

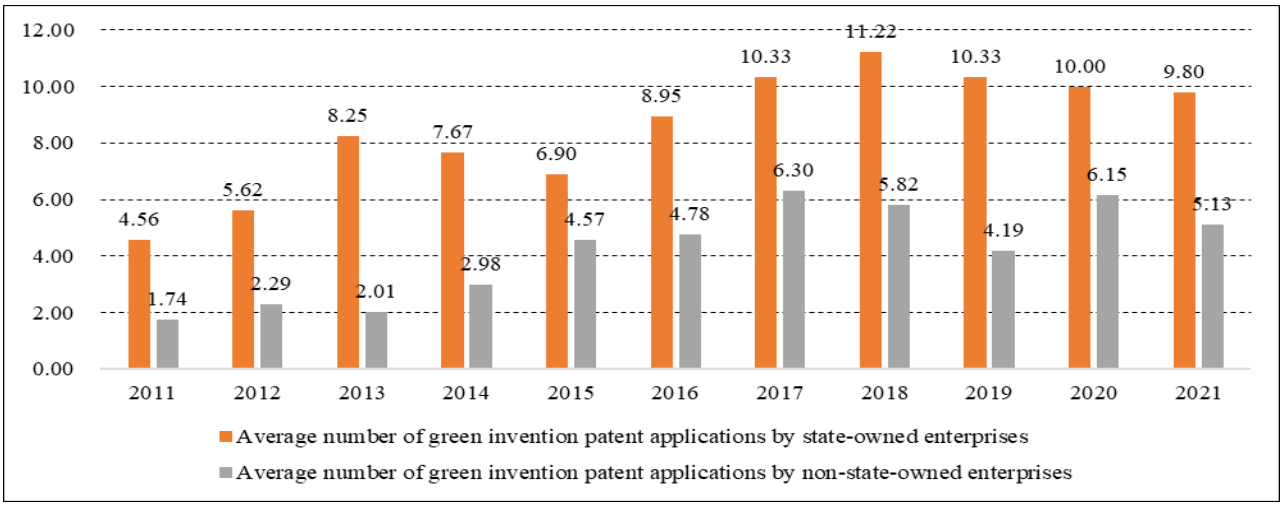


Sources: Guotai 'an Database

Fig. 1. Total number of green invention patent applications of Chinese manufacturing enterprises from 2012 to 2021.

State-owned and non-state-owned enterprises were compared, and both of them increased the number of patent applications (Fig. 2). With an increase in the number, the average number of green invention patent applications of state-owned enterprises was higher than that of non-state-owned enterprises, and the maximum difference between the two was 6.23. For state-owned enterprises,

the government encourages green innovation with a series of policies for green development, which encourages state-owned enterprises to do R&D. For non-state-owned enterprises, the change in the number was smaller.

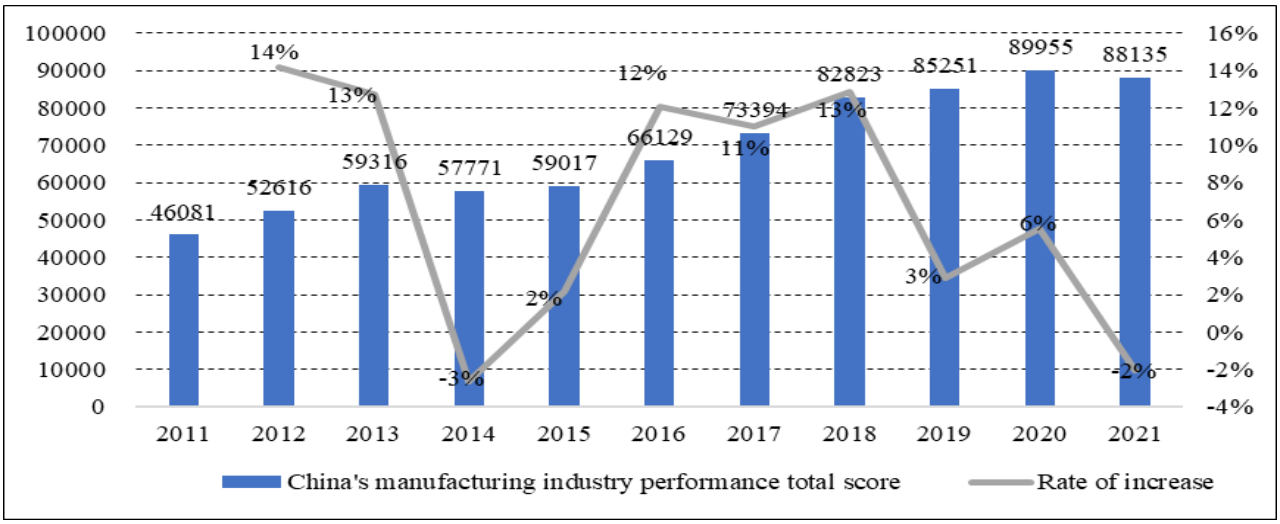


Sources: Guotai 'an Database

Fig. 2. The average number of green invention patent applications of Chinese manufacturing enterprises from 2012 to 2021.

3.2. Performance Development

From 2011 to 2021, the performance of China's manufacturing enterprises improved (Fig. 3) with a growth rate of 14% in 2012 and -3% in 2014. The growth rate gradually declined but increased in 2018 and 2019. From 2019 to 2021, due to the impact of the pandemic, the manufacturing industry experienced a demand decrease, which led to a negative growth trend in 2021. In general, China's manufacturing enterprises have developed considerably in the past with challenges and fluctuations.

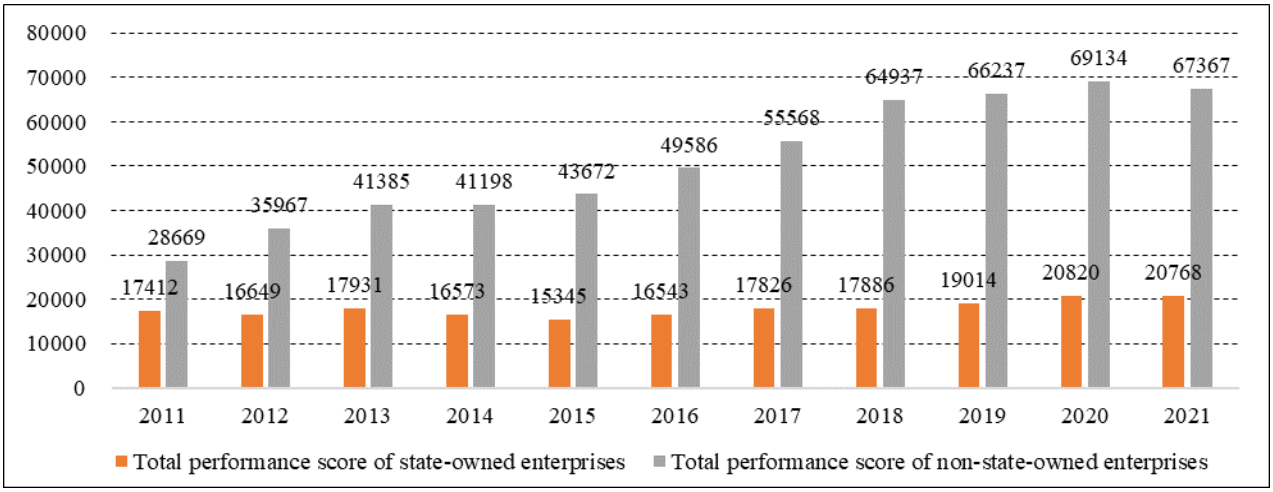


Sources: wind Database

Fig. 3. China's manufacturing industry performance total score and rate of increase.

The performance scores were observed for state-owned and non-state-owned enterprises (Fig. 4). The scores of state-owned manufacturing enterprises showed an increase in the decade with a fluctuation. The overall score increased from 17,412 in 2011 to 20,768 in 2021, indicating that the state-owned manufacturing enterprises improved performance. State-owned enterprises were more stable in making decisions, which also made state-owned enterprises resist risks and maintain stability in market changes. Non-state-owned manufacturing industry improved performance in the same period but the volatility was stronger. China's industrialization accelerated significantly in 2012 and 2013, which affected non-state-owned manufacturing enterprises. The growth rate in these two years was 25.42 and 15.04%. From 2020 to 2021, amid the epidemic, the growth rate decreased to -2.55%, which

indicated that non-state-owned enterprises faced intense market competition and operating pressure. They needed to be more flexible and agile to respond to market changes and take higher risks, which increased volatility in the performance of non-state-owned enterprises.



Sources: wind Database

Fig. 4. Overall score of China's manufacturing performance from 2012 to 2021.

4. Green Innovation Quality

4.1. Empirical Model

A panel model was used to study the impact of green innovation quality on the performance of the enterprise. The model was constructed as follows.

$$ESG_{it} = \alpha + \beta_1 innovation_{it} + \beta_2 M + \nu_i + \nu_t + \varepsilon_{it} \quad (1)$$

where i represents the sample enterprise, t represents the year, ESG_{it} represents the enterprise performance of i enterprise in year t (taking logarithm), $innovation_{it}$ represents the enterprise green innovation quality of i enterprise in year t, α represents constant term, β is the coefficient to be measured, M represents various control variables, ν_i represents time fixed effect, ν_t represents individual fixed effect, and ε_{it} is the error term.

4.2. Variables

The business performance of the ESG rating index of Huaseng (ESG) was selected to measure the performance of enterprises (Gao et al., 2021). Since several enterprises did not apply for any green invention patent in several years, the number of enterprises' green invention patent applications was calculated as *Lninno* to retain a zero value (Liu and Qiu, 2016).

$$Lninno = \ln\left[innovation_{it} + (innovation_{it}^2 + 1)^{1/2}\right] \quad (2)$$

where i represents the sample enterprise, t represents the year, and $innovation_{it}$ represents the quality of enterprise green innovation of enterprise i in the year t.

Considering the factors for enterprise performance, control variables were selected from enterprise nature and financial status. In terms of enterprise nature (Gao *et al*. 2021), enterprise Size (*Size*), enterprise nature (*Soe*), and enterprise Age (*Age*) were chosen as control variables. In financial status, profit rate on total assets (*Roa*), asset-liability ratio (*Lev*), and financing constraints (*Sa*) were selected as control variables (Table 1).

Table 1. Definition and description of variables.

Variable Type	Variable Name		Variable Code	Variable Description
Explained variable	Enterprise performance		*ESG*	Data from China Securities ESG rating data
Explanatory variable	Enterprise green innovation quality		*Lninno*	$\text{Lninno} = \ln[\text{innovation}_{it} + (\text{innovation}_{it}^2 + 1)^{1/2}$
Control variables	Enterprise characteristics	Enterprise scale	*LnSize*	The natural logarithm of a firm's total assets
		Nature of enterprise	*Soe*	The dummy variable is 1 for state-owned enterprises and 0 for other enterprises
		Enterprise age	*LnAge*	The natural logarithm of (corresponding year - year of establishment)
	Financial position	ROTA	*Roa*	Net profit/ending total assets
		TDR	*Lev*	Ending liabilities/ending total assets
		Financing Constraints	*Sa*	The calculation formula is $Sa = -0.737\times Size+0.043\times Size^2-0.04\times Age$

4.3. Data Preprocessing

China's listed manufacturing enterprises from 2011 to 2021 were selected as research objects, and 12,125 observations were obtained by excluding the *st* type enterprise and eliminating missing data. The data were obtained from the ESG rating data of Huaseng in the wind database, and the data of enterprise green innovation were selected from the Guotai 'an database. The data were taken from the logarithm (Dai, 2023). The measurement of enterprise financing constraint (*Sa*) was adopted from Ju *et al*. (2013).

4.4. Analysis and Test Results

4.4.1. Descriptive Statistics

Descriptive statistics were obtained to study the performance of manufacturing enterprises and green innovation from 2011 to 2021, including the average value, standard deviation (SD), minimum value, and maximum value (Table 2). The average number of patent applications was 0.89, the SD was 1.295, and the difference between the maximum and the minimum value was 7.713. This indicated that the green innovation quality of the sample enterprises was relatively low, and there were large differences among enterprises. The average performance score of the explanatory variable was 4.287, the minimum value of the performance score was 3.885, and the maximum value was 4.51. There was a small difference in the performance scores of enterprises. There was a large difference between the maximum and minimum values of various financial data of enterprises.

Table 2. Descriptive statistics.

Variable	Observation	Mean	SD	Min	Max
ESG	12,125	4.287	0.078	3.885	4.510
Lninno	12,125	0.890	1.295	0.000	7.713
Lnsize	12,125	22.232	1.184	17.641	27.547
Lnage	12,125	2.860	0.346	0.916	4.001
Lev	12,125	0.342	0.200	0.000	2.670
Sa	12,125	1.530	0.289	-1.371	2.502
Roa	12,125	0.042	0.117	-5.984	1.144
Soe	12,125	0.269	0.443	0.000	1.000

Sources: The relevant data of enterprise performance comes from the ESG rating data of Huaseng in the wind database, and the quality data of enterprise green innovation comes from the Guotai 'an database.

4.4.2. Hausman Test

To determine the fixed or random effect, Stata 17.0 statistical software was used to perform the Hausman test on the data before conducting the regression analysis. $Chi^2(7) = 628.79$, and the *p*-value was close to 0.00. The hypothesis for random effects was rejected. Therefore, the fixed effect model was selected for further analysis.

4.4.3. Regression Analysis

Stata 17.0 was used for regression analysis (Table 3). The results before the introduction of control variables showed that the influence coefficient of green innovation quality on enterprise performance was 0.0046 at a significance level of 1%, indicating that improving the quality of green innovation significantly improved enterprise performance. After adding control variables, the difference of R^2 of the regression result was 0.0027 at a significance level of 1%. R^2 was 0.879, indicating that the model fitted well. With the control of the size, age, total asset, profit rate, financing constraints, and asset-liability ratio, every 1% change in green innovation quality increased the enterprise performance score by 0.0027, indicating the improvement of enterprise performance by green innovation. The effect of the size was positive. Compared with small and medium-sized enterprises, large-scale enterprises invested more resources in green innovation and produced and purchased environmentally friendly products and technologies at a lower cost, which improved their quality of green innovation. The effect of age was negative. Young enterprises were more likely to accept new concepts and concepts and willing to try new green innovations. They adjusted strategies quickly and had a strong ability to seize market opportunities. They used emerging technologies to promote green innovation which positively affected their green innovation quality. The effect of the asset-liability ratio was negative The low asset-liability ratio means that the enterprise has less debt and liabilities, the operation is more stable and flexible, the financial stability is strong, and the long-term development ability is strong. Thus, it is easier to obtain additional funds for green innovation projects. Therefore, the low asset-liability ratio positively influenced enterprise performance. Financing constraints affected negatively the adoption of technology and collaboration with other institutions. Therefore, lower enterprise financing constraints improved enterprise performance, while higher enterprise financing constraints hindered enterprise performance.

Table 3. Regression analysis results.

Variables	ESG	ESG
Lninno	0.0046***	0.0027***
(t-statistics)	(5.6304)	(3.3766)
Lnsize		0.0573***
		(5.3207)
Lnage		-0.0508***
		(-3.2739)
Lev		-0.0491***
		(-6.2612)
Sa		-0.1494***
		(-3.7239)
Roa		0.0152
		(1.3637)
Constant term	4.2824***	3.4002***
	(5,871.8230)	(18.6077)
TFE	Yes	Yes
FEM	Yes	Yes
Observation	12,125	12,125
R^2	0.559	0.574

4.4.4. Influence of Green Innovation Quality on Enterprise Performance

Considering that enterprise nature impacted the results, the difference between state-owned and non-state-owned enterprises was explored. The results are shown in Table 4. The regression coefficient of state-owned enterprises was 0.0045 at a significant level of 1%. This indicated that for state-owned enterprises, a 1% change in green innovation quality increased the performance score of state-owned enterprises by 0.0045%. The regression coefficient of non-state-owned enterprises was 0.0016 at a significant level of 10%, indicating that the improvement of green innovation affected performance less, indicating that private enterprises did not improve the quality of green innovation. The result showed that non-state-owned enterprises had no significant promoting effect of improved green innovation quality on enterprise performance score.

Table 4. Sub-enterprise nature return.

Variables	SOE. ESG	Non-SOE. ESG
Lninno	0.0045***	0.0016*
(t-statistics)	(3.1455)	(1.6751)
Lnsize	-0.0034	0.0767***
	(-0.2385)	(4.8624)
Lnage	0.0397	-0.0594***
	(1.5125)	(-3.2355)
Lev	-0.0172	-0.0602***
	(-1.4008)	(-6.2183)
Sa	0.0677	-0.1939***
	(1.1707)	(-3.3125)
Roa	0.0113	0.0162
	(0.8837)	(1.0890)
Constant term	4.1415***	3.0680***
	(17.8201)	(11.6160)
TFE	Yes	Yes
FEM	Yes	Yes
Observation	3,230	8,861
R^2	0.593	0.589

4.4.5. Robustness Test

To prove the robustness of the ESG rating for the green transition of enterprises, the core explanatory variable was selected by referring to Feng et al. (2023). The natural pair value of the number of citations of green invention patents plus 1 was used and denoted as Lninno2. The natural logarithm value of the number of patent applications of the listed companies plus 1 was used to measure the quality of green innovation (Zhou, 2023) and recorded as Lninno3 to verify the estimated results. The regression results are shown in Table 5. The regression coefficients were 0.0021 and 0.0029 at a significant level of 1%, which proved the robustness of the model.

Table 5. Explanatory variable.

Variables	ESG	ESG
Linno2	0.0021***	
(t-statistics)	(2.6579)	
Linno3		0.0029***
		(3.4532)
Lnsize	0.0576***	0.0565***
	(5.3403)	(5.2260)
Lnage	-0.0513***	-0.0509***
	(-3.3092)	(-3.2872)
Lev	-0.0494***	-0.0492***
	(-6.2843)	(-6.2379)
Sa	-0.1497***	-0.1470***
	(-3.7322)	(-3.6572)
Roa	0.0152	0.0153
	(1.3592)	(1.3619)
Constant term	3.3964***	3.4142***
	(18.5667)	(18.6249)
TFE	Yes	Yes
FEM	Yes	Yes
Observation	12,123	12,123
R^2	0.574	0.574

5. Conclusions and Recommendations

In “accelerating the construction of a new development pattern with the domestic great cycle as the main body and the domestic and international double cycles promoting each other” in China, regulators, investors, and enterprises attach increasing importance

to green innovation, and more enterprises are investing in green innovation. Using the data of 12,125 listed companies in China's manufacturing industry from 2011 to 2021, the impact of green innovation quality on enterprise performance was explored. The results showed that improving the quality of enterprise green technology innovation promoted enterprise performance, especially for young enterprises with a large scale, and low asset-liability ratio and financing constraints. The effect of the green innovation quality in state-owned enterprises was more significant in improving enterprise performance than in private enterprises. High-quality green innovation helped reduce costs, improve product competitiveness, and gain a larger share of the market. Therefore, manufacturing enterprises must pay more attention to improving the quality of green innovation.

Green innovation is an investment with high costs and investment, and it is difficult to achieve results in the short term. However, flexible policies can alleviate the pressure of high-cost investment required by enterprises for green innovation. The government needs to help companies overcome financial constraints by providing further subsidies, tax cuts, or loans. Second, the government must encourage all types of enterprises to participate in green technology innovation through incentive programs and innovation funds. Such an incentive system can provide enterprises with the motivation and willingness to promote the quality of green innovation. In addition, the government must strengthen environmental publicity and education, and improve the environmental awareness of enterprises through the organization of industry exchanges and experience-sharing activities to help enterprises practice green innovation and implement environmental protection concepts. Finally, the government must supervise and enforce environmental laws and regulations with relevant regulations. The government needs to offer practical incentives and punishments, combining the compulsory role of law with the subjective initiative of enterprises for enterprises to participate in green innovation more actively. The government can promote the green transition of manufacturing enterprises through flexible policy formulation, incentive systems, environmental protection publicity and education, and strengthening the enforcement of laws and regulations. With the joint efforts of the government and enterprises, the positive effect of environmental protection policies can be obtained to transform China's manufacturing industry into green innovation.

Industrial policies related to green innovation provide a better environment for green innovation, stimulate enterprises' positive attitude towards green innovation, promote the improvement of enterprise performance, and reduce pollution emissions and harm to the ecological environment. In industrial policies, the differences between enterprises and market environments must be considered. The government must formulate flexible policy measures, provide targeted support and incentives for enterprises, and provide preferential treatment and convenience in terms of capital, technology, and market access. On the other hand, the government also must guide and train enterprises to improve their ability and level of green technology innovation. At the same time, it is necessary to ensure the rationality and stability of industrial policies and avoid frequent or inconsistent policy adjustments, so, not to bring unnecessary troubles and investment risks. In addition, the government must develop regulatory mechanisms, strengthen the supervision and evaluation of the implementation of enterprise green innovation-related policies, and timely adjust policy measures to ensure effectiveness and sustainability. When improving relevant industrial policies, it is also necessary to disclose information for transparency. It is also important to improve the information disclosure system to timely disclose policies and measures related to green technology innovation, enhance the visibility and fairness of policies, and prevent information asymmetry. In addition, the government must encourage cooperation and sharing among enterprises to promote the transformation of scientific and technological achievements and the optimal allocation of resources in green technology innovation. By strengthening the cooperation between industry, university, and research and promoting technical exchanges and experience sharing between enterprises, the overall level of green technology innovation can be effectively improved and the coordinated development of the industry can be promoted.

The government must formulate flexible and stable policies and measures according to the characteristics of different enterprises and market environments and provide targeted support and incentives for enterprises. At the same time, supervision and information disclosure are necessary to ensure the implementation effect and fairness of policies. Through cooperation and sharing, coordinated development among industries is enabled to promote green technology innovation for economic development and ecological environmental protection.

Financing pressure must be eased for manufacturing enterprises for green innovation. Thus, the government must provide low-interest loans and risk-sharing support for manufacturing enterprises. In particular, small and medium-sized private enterprises mus be assisted with financing support to encourage them to carry out green innovation projects. Banks and financial institutions must increase the scale of green credit, set up green credit quotas, allocate a certain proportion of loans to support green innovation projects of manufacturing enterprises, and reduce the financing threshold and costs for enterprises. At the same time, a green evaluation system must be introduced to give priority financing or interest rate concessions. Governments must develop green evaluation indicators and evaluation methods to ensure that manufacturing enterprises receive fair evaluation and support. Moreover, relevant fiscal and tax policies must be formulated to give incentives such as tax breaks, subsidies, or rewards for green innovation.

At the same time, special funds or incentive programs can be set up to encourage enterprises to carry out green innovation and encourage them to increase investment in green innovation.

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Data Availability Statement: China's listed manufacturing enterprises from 2011 to 2021 are selected as the research object, and the relevant data of enterprise performance comes from the ESG rating data of Huaseng in the wind database, and the quality data of enterprise green innovation comes from the Guotai ' a database.

Conflicts of Interest: The author declares no conflict of interest.

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