Corporate Social Responsibility and Green Innovation—The Mediating Effect of Financing Constraints

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Green innovation has become a strategic direction for the country and enterprises, and it is an important facet in achieving high-quality economic development. Whether corporate social responsibility (CSR), as a key competitive strategy for achieving sustainable economic development, can promote corporate green innovation and the path of evolution has become a hot topic of current research. This paper takes Chinese manufacturing A-share listed companies as its sample and uses Stata software to conduct regression analysis to test the relationship between CSR, financing constraints, and green innovation, respectively. It further distinguishes the sample into different technological properties and different regions to study the degree of differentiation of the mediating effect on financing constraints. The results show that CSR can not only directly promote corporate green innovation, but that it also can further positively influence corporate green innovation by alleviating financing constraints. Financing constraints play a mediating role in the relationship between CSR and green innovation, especially in enterprises with strong innovation demand and in regions with high levels of regional economic development. The findings enrich the research perspective on the relationship between CSR and green innovation and provide realistic data support for subsequent studies.

Keywords: corporate social responsibility, financing constraints, green innovation, stakeholder theory, signaling theory

Introduction

As the concept of sustainable development is put forward, the concept of low-carbon economy constantly appears in the global major issues, the severe ecological problem has become a major obstacle to the realization of sustainable development of China's economy. In the 14th Five-Year Plan, China pointed out that in order to achieve the goal of high-quality development, it must take "innovation-driven development and green development" as the main strategic direction. Green innovation can save social resources, improve production

efficiency of enterprises, realize environmental protection and sustainable development of society. It has become an important driving force to change the traditional production mode of enterprises and promote green transformation of enterprises. Green innovation is regarded as the key means to alleviate the contradiction between economy and ecology as well as achieve sustainable and high-quality economic development.

Corporate stakeholders are increasingly paying more and more attention to the fulfillment of corporate environmental responsibility. As the main body of environmental protection and innovation, corporate social responsibility is not only a requirement of relevant policies, but also a response to potential market demand. At present, economic development and environmental ecology increasingly contradict, corporate social responsibility has become an inevitable path and strategic choice for enterprises to achieve sustainable development (Mirza et al. 2015), as well as a powerful weapon to obtain core competitiveness. Therefore, to study the mechanism of corporate social responsibility and green innovation has long-term significance not only to promote enterprise's core competitiveness, but also to offer reference for the government to further design reasonable classification guidance, optimize the enterprise green innovation activities of financing environment as a whole, strengthen the green innovation motivation, offer possibilities for the government, enterprises, society and other stakeholders, as main body, to jointly create of the win-win situation.

In recent years, the focus on green innovation has become a major motivation for scholars and industry practitioners (Melay et al., 2017; Vallaster et al., 2019), studies on the relationship between corporate social responsibility and green innovation have also made some achievements, but studies on the mechanism of the two are still in the development stage. Considering that enterprises' fulfillment of social responsibility can alleviate financing constraints to a certain extent and financing is an important factor influencing enterprises' green industry upgrading, it is of great significance to coordinate the contradictions and conflicts between enterprises and stakeholders, promote the coordinated development of economy, society and environment (Xiao, Pan and Wang, 2021), and pay attention to the relationship between corporate social responsibility and green innovation as well as financing constraints. The research shows that corporate social responsibility can not only act directly on green innovation, but also reduce information asymmetry and agency cost through the mitigation effect of financing constraints, which will further improve the level of green innovation of enterprises.

The remainder of this paper is organized as follows. Section 2 includes a literature review of corporate social responsibility, financing constraints and green innovation and the research hypotheses. Section 3 presents the research methods, including sample, dataset and variables. Section 4 presents the study results and the robustness tests under various empirical assumptions. Section 5 concludes this paper with a discussion of implications to CSR, financing constraints and innovation field.

Literature Review and Research Hypothesis

Corporate Social Responsibility and Green Innovation

The corporate social responsibility (CSR) enters the public eye and has been widely discussed since the 1950s, but its definition and its connotation are still controversial. However, most scholars believe that CSR should focus on issues other than the company's own economic interests and its shareholders' interests (Davis, 1960; Liu, 1999), encompassing corporate economic, legal, ethical, and philanthropic responsibility (Carroll, 1991) and good citizenship (Hemphill, 2004). In the 1990s, along with the rise of stakeholder theory, there was further refinement of CSR into the responsibility of employees, consumers, business partners, communities, the natural environment, and other subjects of interest (Kim, Brodhag, & Mebratu, 2014). With the deepening

contradiction between economic development and environmental ecology, the demand for corporate social responsibility from interest subjects such as government, civil organizations, and consumers is also increasing, and, as CSR is gradually becoming introduced into corporate strategy, it is becoming the core competitiveness of enterprises in achieving sustainable development.

According to stakeholder theory, CSR practices help enterprises build trust with external stakeholders, and thus, they promote the formation of cooperative networks. In addition, such cooperative networks help enterprises obtain innovation resources, reduce innovation risks, save innovation time and costs, and have a positive impact on corporate green innovation. Stakeholder theory suggests that the exchange and distribution of various resources between a firm and its stakeholders is necessary for its success. Since stakeholders can set norms and can evaluate company behavior, companies must address the needs and the expectations of their stakeholders. On the one hand, the fulfillment of social responsibility by enterprises can reduce information asymmetry, enhance the trust and cooperation of stakeholders, and accumulate good conditions for cooperation and an atmosphere of green innovation. For example, green innovation in processes and products can significantly enhance the social concern of enterprises, and that social concern will force enterprises to take social responsibility for the environment (Ziegler, Schröder, & Rennings, 2008; Yuan & Cao, 2022). By assuming their responsibility for their employees, enterprises can not only create learning opportunities for employees to stimulate their creativity, but enterprises can also attract a large number of talented employees with professional knowledge. These scientific and technological talents can effectively enhance the efficiency of corporate green innovation (Wu & Zhang, 2021).

Meanwhile, consumers, as the most critical external stakeholders of enterprises, are making a demand for green products and quality ecological environment. It is becoming the key driver for enterprises to implement green innovation; due to the change in the public's consumption consciousness, consumers are considering the environmental value behind the products that they are purchasing. Consumers with green preferences are more willing to purchase green products, and consumers' environmental demands for products will bring environmental protection to the management of enterprises, along with pressure to implement positive green innovation behaviors. In addition, community environmental requirements, government environmental regulation, environmental taxes, and related environmental regulations make the cost of emissions higher than the cost of innovation, so companies invest more capital in the production and the innovation of green products and actively assume social responsibility for environmental protection to reduce the cost of environmental pollution (Hu & Zhang, 2020). At the same time, green innovation requires a large amount of capital investment. Companies performing green innovation can convey a strong corporate image to investors, and therefore, they are more likely to obtain external financing (Xiao et al., 2021). Accordingly, the first hypothesis of this paper is proposed:

Hypothesis 1: CSR can actively promote corporate green innovation behavior.

Corporate Social Responsibility and Financing Constraints

Financing constraints. The theory of financing constraints first arose after the M&M Theorem was proposed: In a perfect capital market environment, a firm's investment decision is only related to the firm's own investment needs and is not affected by the firm's financing structure. However, due to the imperfection of real capital markets, the problem of information asymmetry and the existence of agency costs, which make the cost of external financing higher than the cost of internal financing for firms, are considered as the main

reasons for the creation of financing constraints (Hall, 2010). In the context of information asymmetry, financing constraints exist for most firms, but the effect of financing constraints can be more pronounced for more innovative firms (Yung, 2016; Li, 2021).

Financing constraint plays a huge obstacle role in China's economic development and in its enterprise transformation. The financing cost of Chinese manufacturing enterprises has remained high for many years, and the problem of difficult financing has been difficult to solve for a long time. Corporate performance, in terms of social responsibility, has become a criterion for external investors to measure the potential returns and risks of enterprises. According to signaling theory, due to the existence of information asymmetry in the capital market, some enterprises will take a series of actions to transmit relevant information to the market in order to gain the trust and support of stakeholders. The social responsibility of enterprises can send good signals to the outside world, which can accumulate social capital for enterprises to gain social trust and enhance the recognition of the capital market, thus helping enterprises obtain financing. Studies have found a significant negative relationship between CSR information disclosure, information asymmetry, and cost of capital (Michaels & Grüning, 2017). Further, CSR information disclosure can meet the needs of different stakeholders, and it can bring important cost reductions to firms as a license to operate. For example, CSR quality and information disclosure, internal control and social responsibility information disclosure (Li & Cao, 2021), and media attention (Lu & Zhang, 2021) can all reduce information asymmetry and, thus, can mitigate financing contracts.

From the perspective of the reputation mechanism, corporate fulfillment of social responsibility can build a good reputation; on one hand, a good corporate reputation will make investors believe more in the business ability of a company and this will bring higher and more stable investment returns to investors, so that the company will be able to charge a premium and receive more financial support (Pan et al., 2012; Pfister, Schwaiger, & Morath, 2020). On the other hand, firms can gain good brand reputation through strict control of product quality. This reputation will win the support of external stakeholders and will enhance the credit and risk resistance of firms when they have financing difficulties, thus weakening their financing difficulties to obtain external financing more easily (Wang et al., 2019). From the perspective of stakeholder theory, enterprises fulfilling their social responsibility to the government can obtain a government policy tilt and financial assistance, and enterprises supported by the government are more likely to obtain financing from the market. At the same time, CSR exerts pressure on internal corporate governance, and this further promotes the improvement of corporate financial performance, thus enhancing internal financing capacity to alleviate the constraints of external financing. Moreover, corporate fulfillment of social responsibility can attract and retain better quality stakeholders, and good social responsibility performance can attract some of the more socially conscious consumers and collaborators. Based on the above analysis, the second hypothesis of this paper is proposed.

Hypothesis 2: CSR can alleviate financing constraints.

Corporate social responsibility, financing constraints, and green innovation. Green innovation activities require large and continuous financial investments, and the returns and the duration obtained are difficult to estimate. This can result in a financial dilemma for many firms attempting green innovation. It has been found that R&D investment stimulates a large amount of financing needs; for example, the long-term debt and amount of financing of firms are found to be positively correlated with R&D investment (Carpenter & Petersen, 2002; Martinsson, 2010), and that financing constraints can hinder the innovation ability of firms and

can discourage them from gaining competitive advantage (Maurer, 1999). Increased competition enhances financing constraints, and innovative firms choose to increase their internal cash holdings to mitigate the inhibiting effect of financing constraints on firm innovation (He & Wintoki, 2016), but on the other hand, green innovation can promote the corporate disclosure of social responsibility information, thereby alleviating financing constraints.

It is also found that equity financing can effectively promote corporate innovation, but debt financing is simple and has a "tax shield" effect and the combination of the two approaches can combine to promote corporate innovation R&D. The long-term nature of innovation activities and information asymmetry imposes serious financing constraints on green innovation (Cheng et al., 2021), and the financing constraints inhibit firms' innovation decisions and reduce the number of their innovation outcomes. When the R&D spillover effect is large enough, CSR inhibits the level of firms' own innovation investment and is detrimental to the innovation of production technology.

Due to the double externality characteristics of green innovation, in order to avoid imitation by potential competitors, firms may be reluctant to fully disclose the details of their innovation strategies, which may intensify the degree of information asymmetry between external investors and firms and may lead to an increased degree of financing constraints. At the same time, green innovation projects are special in nature, further aggravating principal-agent costs and preventing firms from accessing the financial needs of innovation activities. According to the principal-agent theory, the active fulfillment of social responsibility by enterprises can enable principals to have a clearer understanding of agents, can minimize agency conflicts and agency costs, and can alleviate financing difficulties. According to signaling theory and the reputation mechanism, the good reputation and brand value created by enterprises' undertaking social responsibility to transmit a strong economic and truly responsible public image to the outside world can reduce information asymmetry, can lower financing costs, can alleviate financing constraints, and ultimately can promote enterprises' investment in green innovation. Based on the above analysis, the third hypothesis of this paper is proposed.

Hypothesis 3: CSR can promote corporate green innovation by alleviating financing constraints.

Enterprise technology heterogeneity grouping. The original technology endowment of enterprises may affect their technological innovation demand. The government has a more urgent demand for the green transformation of high-tech enterprises, and less tolerance for the rough production behavior of high-tech enterprises, while high-tech enterprises themselves have a strong demand for green innovation in order to cope with fierce market competition. The main constraint on the green innovation of high-tech enterprises at present is the financing constraint. Once the enterprises reduce the financing constraint by some means, such as fulfilling social responsibility, they will have more abundant capital and they will be more eager to invest in R&D innovation, thus greatly improving their green patent applications, while non-high-tech enterprises, because their competition is not mainly technology competition, even after relieving the financing demands, do not have sufficient motivation to invest in R&D innovation. In general, non-high-tech enterprises are more likely to use financing to expand production, to capture market share, and for other conventional competitive methods. Therefore, the mediating mechanism of financing constraint between social responsibility and green innovation is significantly weaker. Based on the above analysis, Hypothesis 4 of this paper is proposed.

Hypothesis 4: Financing constraints play a greater mediating role in high-tech firms.

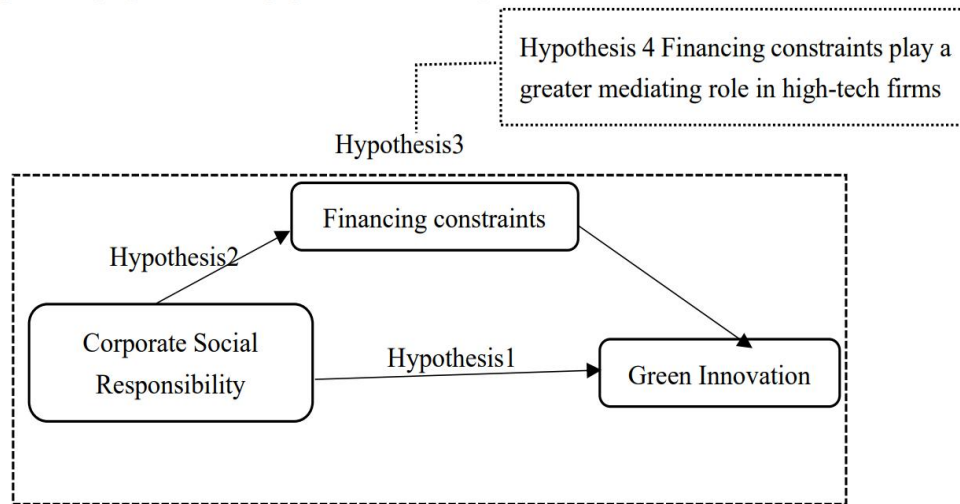The hypothesis proposed in this paper is shown in Figure 1.

Figure 1. Hypothetical framework.

Study Design

Sample Selection and Data Sources

China has proposed manufacturing industry upgrading in the 2011-2015 plan and a new development concept of "green and innovation" in the 2016-2020 plan, so the research period for this paper is selected as 2011-2020. Among Chinese A-share listed companies, manufacturing enterprises, as the main support of China's real economy, bear the important responsibility of production and R&D. The competition in innovation is very fierce, especially after the national call for supply-side structural reform and the transformation of the economic development mode. The demand for green transformation of manufacturing enterprises has been increasing, and green patents are playing a strong role in promoting the transformation of enterprises. In fact, manufacturing enterprises are also the main contributors to green patents among Chinese microeconomic agents. Therefore, this paper mainly selects manufacturing enterprises among Chinese A-share listed companies as its research sample. To ensure the validity of the data, the sample selection follows the following principles: (1) It excludes ST and *ST companies; (2) it excludes companies with missing and abnormal data of main variables; (3) it excludes companies listed later than 2010; and (4) it excludes companies with zero number of green patent applications during the study period. After the above processing, a total of 4,650 observations were finally obtained from the 10-year balanced panel data of 465 manufacturing companies. The CSR scores were obtained from the total social responsibility scores released by Hexun, the green patent data were obtained from the "IPC Green List" released by the World Intellectual Property Organization (WIPO) and retrieved from the State Intellectual Property Office, and the other data were obtained from the Guotaian database (CSMAR). The data were pre-processed with Excel software and statistically analyzed with Stata 16.0.

Variable Settings

Explained variables. The explanatory variable in this paper is green innovation (hereinafter referred to as GI). Rapid economic development is accompanied by serious environmental problems, such as high energy consumption, pollution, and emissions. Green innovation is considered as an important way to alleviate the contradiction between high economic growth and severe environmental pollution. Advances in green innovation improve the utilization of natural resources, reduce production costs, and improve eco-efficiency.

When considering the output of corporate green innovation (GI), there are various measures used: usually green innovation efficiency, green innovation input, and green patents. Considering that green innovation is characterized by double externalities and noting that the patent system can deal with the externalities of enterprise R&D costs to a certain extent, this paper adopts green patent applications as a proxy variable for green innovation (Ye, 2021). The reason for adopting the number of green patent applications, rather than the number of grants, as a measure of the degree of green innovation of enterprises, is that it often takes 1-2 years from the application to the granting of a patent. This process is characterized by a lag, so choosing the number of green patent applications as a measure can make the conclusion more robust. In addition, due to the nature of the industry, the degree of green innovation of enterprises may vary greatly among different industries. To avoid interference with the empirical results, the total number of green patent applications is chosen to be treated as logarithm after +1.

Explanatory variables. The explanatory variable in this paper is corporate social responsibility (CSR). In the current research of scholars, the main measures of it are the reputation index method, the questionnaire survey method, the content analysis method, the dummy variable method, the accounting index method, and the charitable donation method. The organizations that use the reputation index method to score the CSR situation mainly include the Hutchison Ruling and the CSR Research Center of Chinese Academy of Social Sciences (Song, 2021).

In this paper, the comprehensive CSR score published by Hexun.com is used to evaluate the social responsibility behavior of companies (Shen et al., 2021). The score is based on the social responsibility reports and the financial report information of Chinese listed companies, and it sets up 13 secondary indicators and 37 tertiary indicators in five aspects: shareholder responsibility; employee responsibility; supplier, customer, and consumer rights responsibility; environmental responsibility; and public responsibility, which can reflect the social responsibility performance of enterprises more comprehensively and objectively, and is evaluated for all listed companies. Its data can be obtained directly from the official website, and the evaluation score results are generally accepted by the public.

Intermediate variables. Since financing constraints cannot be directly observed, proxy variables are mostly used, as among them these three commonly used indices: the Kaplan-Zingales (KZ) index, the Hadlock-Pierce (SA) index, or the Whited-Whu (WW) index (Farre-Mensa & Ljungqvist, 2016). The KZ index is chosen as a measure of financing constraints due to its lack of stability when heterogeneity is high and sample size is large (Whited & Wu, 2006) and over-reliant on Tobin's Q (Erickson & Whited, 2005). While the WW index is usually confounded by endogeneity problems, the SA index is chosen as a measure of financing constraints; the SA index is calculated as follows:

$$SA = -0.737 \times SIZE + 0.043 \times SIZE^2 - 0.04 \times AGE$$

where SIZE is the logarithm of the firm's total assets in millions and AGE is expressed as years of observation—years on market + 1. Since the calculated financing constraint index is negative, the larger the financing constraint index, the smaller the degree of financing constraint to which the firm is subjected (Ju et al., 2013).

Control variables. The green innovation output of an enterprise is influenced by various factors. Generally speaking, the change in the number of green patent applications of an enterprise in the current period is the result of the combined effect of various factors. In order to avoid omission of variable bias, this paper

introduces a series of financial indicators that may affect the green innovation output of enterprises as its control variables. With reference to the relevant literature studies, the following variables are selected as control variables in this paper:

(1) Return on Assets (ROA): The profitability of an enterprise is directly related to its development status; it also indirectly affects the resource input of green innovation, so it is necessary to include in the regression to narrow the omitted variable bias.

(2) R&D investment intensity (RD): As the input side of green patents, the adequacy of R&D funds also directly affects the patent output of enterprises and, under the same circumstances, the patent output of enterprises with large R&D investment is higher. In this paper, we control the ratio of R&D investment funds to business revenue to strip the impact of resource investment on green innovation and to enable us to estimate the net impact of social responsibility on green innovation more precisely.

(3) Gearing ratio (LEV): As a business organization aiming at business, it has become common in the industry to obtain sufficient operating capital by means of financial leverage; financial leverage is also directly related to profitability and debt space, which affects the R&D decisions of green innovation.

(4) Cash holding level (CASH): Cash flow is one of the most important direct financial intermediaries in innovation activities. Stable cash flow is the guarantee for enterprises to obtain external financial intermediaries, and the level of enterprise capital affects the ability of enterprises to green innovation.

(5) Ratio of independent directors (INDE): The board structure of an enterprise reflects the enterprise's shareholding structure as well as the complexity of the enterprise's business decision-making processes; this will have a certain impact on the enterprise's green innovation.

(6) Nature of property rights (SOE): There are many SOEs among the listed companies in China's manufacturing industry. Although they are profit-oriented and self-sustaining, and they are free to make decisions on green innovation, the nature of the enterprise inevitably affects the green innovation of the enterprise. On the one hand, SOEs are backed by the state and have more advantages than private enterprises in terms of enjoying corporate social responsibility and tax benefits, and cooperating with state colleges and research institutes in innovation, etc. On the other hand, SOEs also bear certain responsibilities for economic development, and under the call of building an innovative country, SOEs inevitably pay more attention to corporate green innovation.

(7) Enterprise size (SIZE): The asset size of enterprises has a great influence on R&D and innovation investment and is not unrelated to the output of patent results. It is necessary to introduce enterprise asset size as a control variable to avoid the estimation bias that may result from the omission of this factor.

(8) Enterprise technology nature (HT): On one hand, high-tech enterprises themselves have a higher demand for innovation; on the other hand, because high-tech enterprises are regulated and restricted by government policies, they pay more attention to the fulfillment of environmental responsibilities, and therefore, they have a stronger demand for green innovation than non-high-tech enterprises do. The definition chart for each variable is shown in Table 1.

Table 1

Variable Definition and Description

Variable type	Variable code	Variable name	Variable definition
Explained variables	LNGI	Green innovation	Ln (Total number of green patent applications +1)

Table 1 to be continued

Core explanatory variables	CSR	Social responsibility	Annual ratings of listed companies' social responsibility in Hexun
Intermediate variables	SA	Financing constraints	Financing constraints SA index
Control variables	ROA	Return on Assets	Net profit/total assets
	RD	R&D investment intensity	Amount of R&D investment/operating profit
	LEV	Gearing ratio	Liabilities/total assets
	CASH	Cash holding levels	Monetary funds/total assets
	INDE	Percentage of independent directors	Number of independent directors as a percentage of the board of directors
	SOE	Nature of business	State-controlled enterprises take the value of 1, otherwise take 0
	SIZE	Enterprise size	Ln (Total assets)
	HT	Industry Nature	High-tech enterprises take the value of 1, otherwise take the value of 0

Model Building

The traditional methods for testing mediating effects include causal stepwise regression, Sobel's test for mediating effects, and Bootstrap sampling. Given that Chinese scholars currently mainly use Wen Zhonglin and Ye Baojuan's (2014) test for mediating effects to achieve the test for article questions (Gao et al., 2022), this paper mainly refers to the procedure for testing mediating effects proposed by Wen Zhonglin.

Since there is an obvious correlation between enterprise innovation ability and time factor, and since the policies introduced by the government in different periods will have an impact on enterprise green innovation decision, in order to avoid the interference of the natural changes of enterprise green innovation due to time factors on the regression estimation, this paper adds the time fixed effect on the basis of the industry fixed effect model in the previous paper and establishes the industry-time bi-directional fixed effect model.

To test Hypothesis 1: CSR promotes green innovation, Model 1 was developed:

$$LNGI_{it} = \alpha_0 + \alpha_1 CSR_{it} + \alpha' \sum Control_{it} + \sum year_t + \sum Industry_t + \varepsilon_{it}$$

To test hypothesis 2: CSR will alleviate financing constraints, Model II is developed:

$$SA_{it} = \beta_0 + \beta_1 CSR_{it} + \beta' \sum Control_{it} + \sum year_t + \sum Industry_t + \varepsilon_{it}$$

To test hypothesis 3: CSR promotes green innovation by alleviating financing constraints, Model III is developed:

$$LNGI_{it} = \mu_0 + \mu_1 CSR_{it} + \mu_2 SA_{it} + \mu' \sum Control_{it} + \sum year_t + \sum Industry_t + \varepsilon_{it}$$

Take Model I as an example: The subscript i is the individual enterprise, t is the year, α is the coefficient, α_0 is the constant term, Control is the control variable, year is the year, Σyear is the time fixed effect for controlling the difference of innovation capability of the same enterprise in different time periods, ΣIndustry is the industry fixed effect for the inherent difference between the two types of manufacturing industries to which each enterprise belongs at the same time itself, and εit is the residual term.

First, the regression test is conducted for Model I. If the coefficient α_1 is significant, then Model II and Model III are tested. If the coefficient α_1 is significant, it means that CSR has an impact on green innovation. Under the premise that the coefficient α_1 is significant, if both coefficients β_1 and μ_2 are significant, and if μ_1 is also significant, it indicates that there is a partial mediation effect of financing constraints (SA); if both

coefficients β_1 and μ_2 are significant and μ_1 is not significant, it indicates that there is a full mediation effect of financing constraints (SA). If at least one of β_1 and μ_2 is insignificant, a Bootstrap test is required. If the test result is significant, the mediation effect is considered to exist and, vice versa, the mediation effect does not exist.

In this paper, Grouping Hypotheses 4 are grouped regressions on the basis of the total sample, and grouping refinement is used to study the magnitude of the mediating effect, so Model III is applied to Hypotheses 4 equally.

Empirical Results and Analysis

Analysis of Regression Results for the Total Sample

Based on the econometric Model I, Model II, and Model III established in the previous section, this paper uses Stata 16.0 econometric software to perform empirical regression analysis on the data and to obtain the regression results as shown in Table 2. The relationship between social responsibility (CSR) and corporate green innovation (LNGI) is tested according to Model I under the premise of controlling for industry-time fixed effects and adding control variables to reduce omitted variable bias. The regression results of Model I show that the coefficient α_1 of social responsibility (CSR) and green innovation (LNGI) is significantly positive and can pass the test of significance level, which means that the fulfillment of social responsibility by enterprises can significantly improve their green innovation ability. Quantitatively, the value of the CSR coefficient is 0.002, indicating that every one-point increase in social responsibility will make the green patent applications of enterprises rise by 0.2 percentage points. This indicates that the social responsibility behavior of enterprises can effectively stimulate them to improve their green innovation level, and that the innovation mechanism of enterprises will gradually develop and improve with the promotion of social responsibility.

Thus, Research Hypothesis 1 of this paper is verified. The regression results of Model II show that the coefficient β_1 of CSR and SA is significantly positive at 1% significance level, and the correlation coefficient is positive, but negative in substance, because the SA index is negative, indicating that CSR in Chinese manufacturing listed companies can all alleviate the degree of financing constraints faced by enterprises to some extent. That is, by fulfilling CSR, enterprises can create a better social image, build better social relationships, and alleviate financing constraints, and Hypothesis 2 of this paper is verified. Model 3, the coefficient μ_2 of financing constraint (SA) and green innovation (LNGI) is significantly positive at the 1% level, indicating that the greater the degree of financing constraint, the fewer green innovation activities are undertaken by listed Chinese manufacturing companies. Since α_1, β_1, and μ_2 are significant, there is a significant mediating effect of financing constraint in the full sample. The coefficient μ_1 of social responsibility (CSR) and green innovation (LNGI) is significantly positive at the 1% level, and $\beta_1\mu_2$ has the same sign as μ_1, so this mediating effect is a partial mediating effect, and Hypothesis 3 of this paper is verified.

Table 2

Baseline Return

	(1)	(2)	(3)
	LNGI	SA	LNGI
CSR	0.002**	0.001***	0.002**
	(2.33)	(4.17)	(2.09)
SA			0.251***

Table 2 to be continued

			(3.81)
ROA	0.441**	0.138**	0.406*
	(2.04)	(2.42)	(1.91)
RD	1.062**	0.161	1.021**
	(2.28)	(1.56)	(2.29)
LEV	0.685***	-0.141***	0.721***
	(6.99)	(-6.22)	(7.37)
CASH	0.657***	0.123***	0.626***
	(5.16)	(4.46)	(4.91)
INDE	0.177	0.070	0.159
	(0.74)	(1.27)	(0.66)
SOE	0.100***	-0.139***	0.135***
	(3.17)	(-18.80)	(4.17)
SIZE	0.308***	-0.011**	0.311***
	(17.90)	(-2.10)	(18.27)
HT	0.026	0.070***	0.008
	(0.63)	(6.33)	(0.20)
N	4,650	4,650	4,650
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
r2	0.269	0.330	0.271

Notes. ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively.

Analysis of Sub-sample Regression Results

In this paper, the high-tech enterprise sample accounts for 82.6% of the full sample, the non-high-tech enterprise sample accounts for 17.4% of the full sample, and the regression analysis is conducted according to Model III respectively. The regression results of enterprise technology nature sub-sample are shown in Table 3.

Table 3

Return of Technological Heterogeneity

	(1)	(2)	(3)	(4)	(5)	(6)
	LNGI	SA	LNGI	LNGI	SA	LNGI
CSR	0.002**	0.001**	0.001**	0.003	0.000	0.003
	(2.45)	(2.53)	(2.30)	(0.80)	(0.07)	(0.79)
SA			0.070*			0.580*
			(2.05)			(2.02)
ROA	0.623**	0.224***	0.607**	0.204	-0.029	0.221
	(2.40)	(6.55)	(2.32)	(0.27)	(-0.36)	(0.29)
RD	0.770**	0.083	0.764**	1.613**	0.634**	1.245*
	(2.88)	(0.81)	(2.85)	(2.47)	(2.09)	(1.83)
LEV	0.682***	-0.130*	0.691***	0.745	-0.083	0.793*
	(11.57)	(-2.05)	(11.74)	(1.65)	(-0.69)	(1.78)
CASH	0.601***	0.112***	0.593**	0.734	0.196	0.620
	(3.11)	(6.47)	(3.07)	(1.37)	(0.96)	(1.24)
INDE	0.427	0.094***	0.420	-0.092	-0.113	-0.026
	(1.19)	(3.27)	(1.18)	(-0.06)	(-0.30)	(-0.02)
SIZE	0.292***	-0.033**	0.294***	0.386***	0.070	0.345***
	(4.04)	(-2.88)	(4.07)	(4.26)	(1.49)	(3.78)

Table 3 to be continued

SOE	*0.171***	*-0.120****	*0.180***	*-0.150*	*-0.182***	*-0.045*
	(2.82)	(-5.18)	(3.01)	(-0.64)	(-2.07)	(-0.21)
N	3,840	3,840	3,840	810	810	810
Industry	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes
r2	0.262	0.346	0.262	0.420	0.408	0.435

Notes. ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively.

According to the regression results in the above table, it can be seen that the coefficient of social responsibility (CSR) is significantly positive for green innovation (LNGI) and significantly positive for financing constraint (SA) in the sample of high-tech enterprises. The coefficient of social responsibility (CSR) is still significantly positive for green innovation (LNGI) after the mediating variable financing constraint (SA) is added, which shows that high-tech enterprises alleviate their social responsibility by financing constraint; they use financing for green innovation and improve the innovation outcome. In contrast, this performance is not significant in non-high-tech enterprises. In summary, financing constraints play a greater mediating role in high-tech enterprises, and the Research Hypothesis 4 of this paper is verified.

Robustness Tests

Bulleted lists look like this. Considering that the fulfillment of corporate social responsibility may affect green innovation and that green innovation, in turn, may have an impact on corporate social responsibility and on financial indicators in the current period, which may lead to endogeneity problems, this paper refers to the study of Cuihong Ye (2021) and selects the lagged term of the number of green patent applications to replace the number of green innovation applications in the current period for regression testing. The regression results are shown in Table 4.

Table 4

Endogeneity Test

	(1)	(2)	(3)
	L2LNGI	SA	L2LNGI
CSR	0.002**	0.001***	0.002**
	(2.16)	(4.17)	(1.96)
SA			0.198***
			(2.69)
ROA	-0.077	0.138**	-0.107
	(-0.32)	(2.42)	(-0.44)
RD	1.078**	0.161	1.049**
	(2.53)	(1.56)	(2.55)
LEV	0.679***	-0.141***	0.698***
	(6.51)	(-6.22)	(6.69)
CASH	0.640***	0.123***	0.639***
	(4.17)	(4.46)	(4.16)
INDE	0.282	0.070	0.256
	(1.05)	(1.27)	(0.95)
SOE	0.092***	-0.139***	0.121***
	(2.60)	(-18.80)	(3.32)
SIZE	0.300***	-0.011**	0.301***

Table 4 to be continued

	(15.89)	(-2.10)	(16.13)
HT	0.020	0.070***	0.006
	(0.44)	(6.33)	(0.13)
N	3,720	4,650	3,720
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
r2	0.269	0.330	0.270

Notes. ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively.

As shown in Table 4, in Column (1), the coefficient α_1 of CSR and L2LNGI is significantly positive at the 5% level, which verifies Hypothesis 1; in Column (2), the regression results of CSR and SA are consistent with those in the benchmark regression, which verifies Hypothesis 2; in Column (3), the coefficient μ_2 of CSR and L2LNGI is significantly positive at the 1% level, and $\beta_1\mu_2$ is the same sign as μ_1, which verifies Hypothesis 3. Therefore, the regression results, after lagging the number of green patent applications by two periods, are consistent with the results of the benchmark regression, and the conclusions of this paper are always robust.

Substitution of variables method. Referring to previous studies, this paper selects the investment-cash flow sensitivity index to replace the SA index to measure financing constraints (Fazzari, Hubbard, & Petersen, 1988; Chen & Chang, 2019). Internal cash flow is measured by COF, COF = net cash flow from operating activities/total assets, and its coefficient indicates the sensitivity of a firm's innovation activities to internal cash flow, i.e., the degree of financing constraints imposed (Zhang, 2021). The regression results are shown in Table 5.

Table 5

Regression With Replacement Variables

	(1)	(2)	(3)
	LNGI	COF	LNGI
CSR	0.002**	0.001***	0.002**
	(2.33)	(6.91)	(2.11)
COF			0.191*
			(1.69)
ROA	0.441**	0.252***	0.393*
	(2.04)	(5.81)	(1.82)
RD	1.062**	-0.084***	1.078**
	(2.28)	(-2.62)	(2.29)
LEV	0.685***	-0.008	0.686***
	(6.99)	(-0.77)	(7.00)
CASH	0.657***	0.032**	0.651***
	(5.16)	(2.25)	(5.11)
INDE	0.177	-0.011	0.179
	(0.74)	(-0.43)	(0.74)
SOE	0.100***	-0.015***	0.103***
	(3.17)	(-4.68)	(3.26)
SIZE	0.308***	0.000	0.308***
	(17.90)	(0.09)	(17.90)
HT	0.026	0.002	0.026

Table 5 to be continued

	(0.63)	(0.39)	(0.62)
N	4,650	4,650	4,650
Industry	Yes	Yes	Yes
Year	Yes	Yes	Yes
r2	0.269	0.147	0.269

Notes. ***, **, and * refer to 1%, 5%, and 10% significance levels, respectively.

As shown in Tables 5, in Column (1), the regression results of CSR and LNGI are consistent with the previous paper; in Column (2), the direction and significance of the coefficients β_1 of CSR and COF remain consistent with those in the benchmark regression; in Column (3), the coefficients μ_2 of COF and LNGI are significantly positive at the 10% level, and $\beta_1\mu_2$ is the same sign as μ_1. The regression results, after replacing the variables, are consistent with the baseline regression results, so the conclusions of this paper are robust.

Discussion

Corporate social responsibility can both directly promote corporate green innovation and can indirectly enhance corporate green innovation by alleviating financing constraints. Therefore, based on the enterprise level, in the context of the actively advocated green economy, enterprises should clearly realize that fulfilling social responsibility can broaden financing channels, reduce financing barriers, and obtain more financial support for green innovation. On the other hand, with the continuous development of the concept of social responsibility, social welfare is only a small part of corporate social responsibility behavior, and it is imperative to balance the relationship between various stakeholders to seek a long-term development strategy for enterprises. Green innovation, as the core competitiveness of enterprises, brings continuous development power to enterprises, and reasonable allocation of enterprise resources can promote both CSR and green innovation to release a good driving effect. Therefore, enterprises should integrate the relationship between CSR and green innovation, adhere to the principle of "two hands", and strengthen the CSR strategy based on green innovation, so as to accelerate the strategic upgrading of Chinese listed companies with a multiplier effect.

Based on the government level, relevant government departments should improve relevant policies on CSR disclosure and should carry out quality control and supervision, assist in a constructive reward and punishment system, force enterprises to improve the quality of their CSR information, make CSR information more helpful for the use of various interests of enterprises, and improve the value of CSR reports. The improvement of the quality and the value of CSR information can enhance investors' confidence and can bring a boost to alleviate the financing constraints of enterprises. On the other hand, considering that green innovation itself has the characteristics of large investment and a high risk, this makes the innovation financing constraint greater than other investment projects. In the capital market, as the key to enhancing the overall innovation ability of enterprises, it is necessary for the government to provide policy support for enterprises' green innovation activities, to establish a supporting financing system, and to provide a better financing environment for enterprises' green innovation. By encouraging the public, banks, and other financial institutions to invest capital in the field of green innovation to broaden the financing channels of enterprises and to formulate tax incentives for enterprises that meet the conditions of green innovation to increase their innovation funds, an easing of the financing constraints of green innovation of enterprises can be achieved.

Conclusion

The higher the degree of corporate social responsibility fulfillment, the greater the green innovation output will be; there is a significant positive relationship between the two. Based on theories such as stakeholder theory, information asymmetry theory, and signaling theory, this paper analyzes the role path of social responsibility in promoting green innovation for the following three main reasons: First, corporate social responsibility fulfillment will improve the efficiency of corporate green innovation; second, corporate social responsibility fulfillment can improve corporate reputation and can further prompt green innovation investment; third, corporate social responsibility can promote the relationship with stakeholders, which in turn will feed back information favorable to green innovation. CSR can guide enterprises to pay attention to their own environmental responsibilities and, thus, promote their investment in and their ability to implement green innovation activities; this will further realize green ecology and long-term sustainable development.

CSR can alleviate the degree of financing constraints faced by enterprises, and there is a significant negative relationship between the two. On one hand, corporate social responsibility can enhance corporate reputation, and reputation capital as a heterogeneous resource of enterprises can enhance competitive advantages in the capital market to alleviate the degree of financing constraints; on the other hand, actively undertaking social responsibility and disclosing social responsibility information can improve the information transparency of enterprises in the capital market and can alleviate the information asymmetry problem (J. Zhang & Y. Z. Zhang, 2021), which can reduce agency costs and reduce financing constraints.

Green innovation activities are characterized by high investment, long cycle, and high risk; these often face large financing constraints. The active social responsibility of enterprises can serve as a signal of good business operation to investors, enhance investors' investment confidence, and alleviate the financing difficulties faced by enterprises in green innovation. High-tech enterprises, due to their strong innovation demand, can promote their green innovation output to a greater extent when their financing constraints are alleviated. Listed manufacturing companies, influenced by local policies and by the environment, have a stronger demand for green innovation, and thus have a stronger desire to promote corporate green innovation by alleviating financing constraints through fulfilling social responsibility.

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