

Article

Theoretical Evidence for Green Innovation Driven by Multiple Major Shareholders: Empirical Evidence from Chinese Listed Companies

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Abstract: The green innovation strategy has gradually become the key for enterprises as micro-economic entities to gain competitive advantages and adapt to complex changes in the external environment. Using the data of A-share listed companies in Shanghai and Shenzhen from 2010 to 2020, this paper empirically explores the impact and specific mechanism of the ownership structure of multiple major shareholders on the green innovation of enterprises. The results show that, compared with the shareholding structure of a single major shareholder, a publicly traded company with a multi-stakeholder ownership structure has a higher level of green innovation. The mechanism test shows that the equity arrangement of multiple major shareholders promotes green innovation by alleviating the fluctuation in the cash flow of the enterprise. This paper further examines the effect of regulation of multiple major shareholders on corporate green innovation and finds that green finance and the protection of intellectual property can form an effective complementary mechanism with the equity arrangement of multiple major shareholders, thereby strengthening the green innovation of enterprises. After the robustness test is carried out by the double-difference method, the two-stage instrumental variable method, and the substitution variable method, the empirical results of this paper are still valid.

Keywords: multiple major shareholders; green innovation; cash flow volatility; green finance; intellectual property protection



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1. Introduction

Nowadays, the malignant change of global climate becomes a huge challenge to countries around the world and provides an impetus for reflection for the development and revolution of global economics. The low-carbon green economy has gradually become a new trend for global economic development. It is the unshirkable responsibility for each country to build a community of shared future for humanity together and promote the transformation and up-gradation of the national economy towards a low-carbon, green model. A new round of technological revolution guides the global economy to make historical changes. Each country around the world is transforming its economy into a green and low-carbon economy, which spurs their developmental patterns from extensive patterns of economic growth to a green intensive model. The World Watch Institute (<https://www.commondreams.org/organization/worldwatch-institute> (accessed on 11 April 2022)) once pointed out that ecological technology innovation will be a key component in determining whether a nation can develop perpetually. Becoming the second-largest economy in the world through rapid economic development for more than 30 years, China has paid a heavy price in resources and environment, whose carbon dioxide emissions are becoming the world's top priority. To cope with the climate change, achieve environmental governance and reach the goal of the Paris Agreement, China made a

commitment to peak carbon dioxide emissions and become carbon neutral to the world, which means that reaching a peak in carbon emissions by 2030 and then achieving net-zero emissions of carbon by 2060 (<https://www.un.org/zh/ga/75/docs/pv.shtml> (accessed on 11 April 2022). “Official Record of the Fourth Plenary Meeting of the Seventy-fifth Session of the United Nations General Assembly, held on Tuesday, 22 September 2020, at 9 a.m.”).

Green innovation is characterized by its capacity to ease environmental pollution and improve ecological quality, which is becoming crucial support for ecological and civilized construction in China [1] and an important strategy to determine if microenterprises can achieve sustainability [2]. In order to achieve the goal of legitimacy [3,4], meet the demands of corporate stakeholders [5], and meet the needs of strategic orientation [6], companies have to carry out green innovation activities. However, the enterprises that are forced to carry out green innovation by internal and external pressures have a great impact on resource production efficiency [7], competitive advantage [8], financial performance [9], goodwill spillover [10,11], and business owner trust [12], all of which have shown better performance. The results show that enterprises that implement green innovation are more likely to profit from fierce competition in the marketplace. The importance of the article lies in the fact that the key strategy for enterprises to carry out green transformation and upgrading is green innovation [13]. A green innovation strategy helps companies minimize their ecological impact and create long-term sustainable goodwill [14]. Under the current increasingly severe environmental pressure, it is of great significance for China to practice the coordinated development of ecology and economy. As a micro-structure of the macro-economy, the research on green innovation-driven enterprises has great practical significance for China to implement the idea of ecological civilization and achieve the goal of carbon peaking and carbon neutrality as soon as possible.

There are two main research motivations for this paper: First, there is a lack of research in previous studies on ownership structure and green innovation [15–17], while ownership structure is an important institutional factor in emerging economies, and its impact on green innovation cannot be ignored [16]. Unlike developed economies, ownership in China is often highly concentrated, and the agency issue that exists primarily in publicly traded companies in China is the conflict of interest between dominant and minority shareholders [18]. With the acceleration of the process of reforming the split share structure in China, the shareholding ratio of controlling shareholders is gradually declining, while the number of shareholders holding more than or equal to 10% of the shares has increased significantly (according to the provisions of China’s “Company Law”, the number of shareholders holding shares individually or collectively with a shareholding ratio of 10% or more have the right to request the board of directors to convene an extraordinary general meeting, and may also intervene through the appointment of directors and senior management in the day-to-day decision-making of a publicly traded company. Shareholders with a shareholding ratio greater than or equal to 10% can be called a major shareholder), that is, a shareholding structure with multiple major shareholders has gradually formed. The dual externalities of green innovation strategy, combined with the inherent high risk and long cycle of innovation [19], make decision-making and implementation difficult, so it is inseparable to have a great discourse of decision-making deployment of the major shareholders of the right. However, few existing studies have explored the driving force of green innovation from the perspective of shareholders, which is an important topic to discuss. Although the ownership structure of multiple major shareholders has become common in countries around the world [20–23], there are still gaps in the research on the impact of equity arrangements of individual major shareholders on green innovation. Second, there has been less attention paid to emerging economies in previous studies of green innovation compared to the background of developed countries [15,24]. With the acceleration of the process of industrialization, the emerging economies represented by China have produced serious environmental problems in the process of rapid economic development. Therefore, this paper believes that research on green innovation in emerging economies such as China is more important.

The theoretical basis of this paper mainly includes principal-agent theory, resource-based view, and institutional theory. Due to the separation of ownership and control, modern corporate enterprises often have serious principal-agent problems. The principal seeks to maximize his own wealth, while the agent is more inclined to obtain a higher remuneration, and at the same time prefers to maximize leisure time, which leads to a certain conflict of interests between the principal and the agent. Resource-based opinion argues that resources are especially important to the fundamental competitiveness of an organization [25]. The introduction of multiple heterogeneous major shareholders in an enterprise brings different resources to the enterprise, including knowledge, technology, capital, etc., which is particularly important for enterprises to carry out green innovation activities [26]. Institutional theory emphasizes that the enterprise is rooted in the institutional environment, so the enterprise will be subject to certain institutional constraints [27]. Just as a sound legal system is more protective of intellectual property rights, it reduces the risk of spillovers from corporate innovation [28], making businesses more motivated to innovate.

According to the sorting out of the relevant literature on the economic consequences of the ownership structure of multiple major shareholders, this paper believes that there is a certain controversy about the influence relationship between multiple major shareholders and green innovation, which will be further demonstrated through empirical research. Regarding the economic consequences of multiple major shareholders, one view is that the ownership structure of multiple major shareholders will exert a positive supervisory and governance effect [29–33]. For the maintenance of the corporate image, social reputation, corporate value, and considerations of long-term corporate value, companies with multiple major shareholders are more inclined to conduct green innovation activities. Another point of view is that the ownership structure of multiple major shareholders will worsen the agency problem of enterprises, that is, the formation of conspiracy interest groups among multiple major shareholders [34,35], which will exacerbate the eviction of enterprises and small and medium-sized shareholders. Due to the inherent high risk and long payback period of innovation, large shareholders who conspire with each other are even less likely to carry out innovation activities. The risks of green innovation activities by enterprises are higher than those of non-green innovation activities [15], and they occupy a greater degree of corporate funds, so this is undoubtedly an obstacle to the behavior of major shareholders to obtain private interests. According to the “collusion view”, companies with multiple major shareholders’ shareholding structures will engage in less green innovation activities than other companies.

The main research questions of this paper are: Does the equity arrangement of multiple major shareholders play a positive supervisory and restrictive role or does it have a negative conspiracy hollowing effect on corporate internal governance? How do the ownership structures of multiple major shareholders affect green innovation? In what context do they play a role? The answers will be given below. The main goals of this paper are: first, to explore the effect of the ownership structure of multiple major shareholders on green innovation; second, to explore the mechanism and path for multiple major shareholders to influence green innovation; and third, to enrich the shareholding structure of multiple major shareholders. Scenario variables for green innovation.

The contributions of this paper are as follows: First, it enriches the research on the driving factors of green innovation at the micro-level. Most of the existing literature have explored the impact of environmental regulations on enterprises’ green innovation from the perspective of formal institutions. Still, this paper believes that this cannot fully answer the driving factors of green innovation in China. Since China is still in a special time of transformation of the economic structure, the degree of perfection of the institutional environment is not consistent across the various regions, making the Chinese legal system incapable of fully fulfilling its supervisory and control role. Therefore, it is very necessary to study the informal system, such as the ownership structure design of enterprises. To this end, from the perspective of corporate governance, this paper introduces

the ownership structure of multiple major shareholders, attempts to answer the impact and role path of multiple major shareholders' equity structures on internal governance, and reveals the internal driving factors of green innovation. Second, the research on the economic consequences of multiple major shareholders has been improved. The current research results can be mainly summarized as "supervision view" and "collusion view". Scholars from the perspective of "supervision" believe that the ownership structure of multiple major shareholders has resulted in the improvement of investment efficiency, the mitigation of financing constraints, the reduction of crash risk, the improvement of corporate social responsibility performance, an increase in corporate value, and the encroachment of interests after the controlling shareholder's equity pledge. However, scholars based on the "conspiracy view" have found that the equity arrangement of multiple major shareholders deteriorates the efficiency of internal governance and damages the innovation behavior of enterprises. However, there is no literature to explore the impact of multiple major shareholders' equity arrangements from the economic consequences of green innovation. Third, it opens the black research box of multiple major shareholders and green innovation, provides a more theoretical basis for scholars to understand the influence of multiple major shareholders on green innovation, and enriches the contextual variables of influence.

The rest of the article is arranged as follows. The second part summarizes the existing research on the economic consequences of multiple major shareholders and green innovation, sorts out the theoretical mechanism of the impact of multiple major shareholders' equity arrangements on green innovation, and puts forward research hypotheses. The third part is the research design of this paper, which introduces the sample and data sources of the empirical data, variable definitions, and empirical modeling. The fourth part first explains the descriptive statistical characteristics of the variables; analyzes the benchmark regression results; tests the mechanism paths and adjustment mechanisms of multiple major shareholders affecting green innovation; and finally uses the double-difference model, two-stage instrumental variable method, substitution variables, and other methods to mitigate the problem of endogeneity and test the robustness of benchmarking regression. The five parts give a general description of the empirical results of this article and propose appropriate counter-measures and suggestions.

2. Literature Review, Theoretical Analysis and Research Hypothesis

Green innovation can be defined as the innovation of process, technology, or system based on the purpose of alleviating environmental pollution [36]. The independent research and development of green products by enterprises has a positive contribution to improving their competitive advantage, shaping enterprise soft power and financial performance [37], and enhancing the market-leading advantage of enterprises [38]. Green innovation of enterprises can reduce energy consumption in the production and manufacturing process by upgrading equipment, introducing technologies, and reengineering processes. It also alleviates the negative externality of the environment and promotes the improvement of enterprise environmental performance [39] to bring technology-leading advantages to enterprises [40]. Therefore, green innovation plays a dual role in improving enterprises' financial performance and environmental performance.

The views of academia on the company governance effect of multiple major shareholders can be summarized as "supervision view" [20,21,29,41,42] and "collusion view" [43]. Scholars based on the "supervision view" believe that the equity arrangement structure of multiple major shareholders formed by listed companies can effectively optimize the internal governance environment and have a good supervision effect. Under the background of a high concentration of equity in China, the controlling shareholders of listed companies may have "tunneling" behavior driven by egoism. When there are multiple major shareholders in a listed company, the non-controlling major shareholders have the motivation to supervise the controlling shareholders, and the phenomenon of damage to the interests of minority shareholders is alleviated. Besides, the behavior of controlling

shareholders to obtain private interests is restrained [44], and the related party transactions, capital occupation, and other behaviors of listed companies are reduced [42]. Even if the supervision of major shareholders over controlling shareholders is not aimed at protecting the interests of minority shareholders, but for sharing control rights to obtain private interests, the bargaining behavior between major shareholders for the private interests of control rights is enough to prevent the interests of minority shareholders from being infringed [45].

A certain political connection is usually established between the major shareholders and the government based on social and political theory. The major shareholders are often more inclined to fulfill their social responsibilities to maintain the corporate social image and the need for social popularity. In recent years, the state has been a strong proponent of building an ecological civilization. Good environmental performance is undoubtedly an excellent answer given by enterprises to their stakeholders. Green innovation activities are important for enterprises to carry out green transformation and improve environmental performance [46]. At the same time, in the context of the concept of environmental protection governance, which surrounds society as a whole, the state's environmental protection interventions and environmental supervision of enterprises are becoming more and more frequent. When enterprises fail to meet the environmental pollution standard, once they are investigated and dealt with, they will cause double losses of capital and reputation and seriously damage the interests of major shareholders. Secondly, with the acceleration of the digital technology revolution, the integration of emerging media and traditional media acts as a bridge for information transmission in the economic market [47]. Corporate environmental governance has evidently become a hot topic for media attention in recent years. When enterprises perform poorly in environmental governance, media reports may cause investors to panic and even use the power of "voting with their feet" to sell shares, resulting in a sharp drop in share prices. This is undoubtedly a serious loss of interest for the major shareholders of the enterprise. Therefore, it can force the enterprise to carry out green transformation and actively carry out environmental governance to a certain extent. Finally, when the internal ownership structure of the enterprise is relatively balanced, the enterprise resources occupied by major shareholders can be effectively released, which provides a resource basis for enterprises to carry out green innovation. The diversified background of other major shareholders and minority shareholders can play a supplementary professional role with the knowledge and technological needs required by green innovation to alleviate the non-professional intervention of "self-interest", controlling major shareholders in enterprise green innovation projects and giving the management sufficient autonomous decision-making space [48].

Based on this, this paper proposes:

Hypothesis 1 (H1a). *The ownership structure with multiple major shareholders has had a positive internal governance effect and promoted the green innovation of the enterprise.*

"Shareholder negativism" hypothesis holds that the self-interest psychology of major shareholders will drive them to make opportunistic behavior [49]; induce them to empty out the company; aggravate the second kind of agency conflict; and drive the management to have a short-sighted tendency and unreasonably occupy organizational resources, so as to "squeeze out" innovation. When major shareholders cannot understand the intention and behaviour of management in innovation decision-making, the major shareholders may intervene to induce the first kind of agency behavior, resulting in the forced interruption of the innovation project. Because the contribution of green innovation to environmental externality cannot be reflected in the form of economic benefits in the short term, it is more obvious as environmental legitimacy and social legitimacy [46]. If there is a motive of collusion among multiple major shareholders to empty the enterprise, they only pay attention to short-term interests. The impact of green innovation on the long-term competitive advantage of enterprises is not enough to induce major shareholders to produce the will of green innovation. From the perspective of incentive compatibility, it is difficult for

green innovation to create high economic benefits for enterprises in the short term, which violates the goal of pursuing short-term private interests of major shareholders of “self-interest”. Major shareholders cannot realize the balance between maximizing enterprise value and satisfying personal private interests through the added value generated by green innovation in the short term. It also weakens the will of key shareholders to implement environmental innovations to a certain extent. At the same time, compared with other forms of innovation, green innovation occupies more funds [50], which is undoubtedly an obstacle to the behavior of major shareholders to seize private interests. The political connection attribute of some major shareholders weakens the driving force of green innovation from government regulation. At the same time, the possible benefit transmission and excessive intervention of major shareholders based on the concept of “collusion tunneling” will also disrupt the established green innovation strategy of the enterprise. Further, in deepening the promotion of a green financial system to promote green innovation in China, major shareholders may illegally occupy external resources on green innovation to pursue personal interests due to the lack of institutional constraints and supervision mechanisms of major shareholders. The research of [51] confirms this view and finds that enterprises may have strategic innovation in order to seek financial and tax support. Driven by opportunistic motivation, the strategic innovation behavior of enterprises has become a tool to convey the interests of major shareholders and cannot be effectively transformed into innovation achievements. On the other hand, even if other major shareholders can effectively restrict the controlling shareholders, under strict monitoring, the controlling major shareholders also question the asymmetry between the benefits and costs of green innovation due to the small decision-making space and low work enthusiasm. Once the enterprise’s green innovation is successful, it will face the potential for knowledge transfer, with other large shareholders sharing the benefits as well. However, if the innovation fails, it will be questioned by other major shareholders, and the innovation enthusiasm of the enterprise will be weakened.

Based on this, this paper proposes:

Hypothesis 1 (H1b). *The ownership structure of multiple major shareholders intensifies the “collusive tunneling” behavior of major shareholders and inhibits the green innovation of enterprises.*

3. Study Design

3.1. Sample Selection and Data Sources

This paper takes the Shanghai and Shenzhen A-share market listed companies from 2010 to 2020 as the initial research sample. It carries out the following processing according to the research needs of the article: Excluding the samples of the financial category, marked as ST, ST*, or PT; abnormal financial indicators; missing data; and the front and rear 1% of continuous variables, 28,859 sample observations were finally obtained. There are three parts to the data presented here. The first part focuses on data on green innovation among publicly traded companies. Data were obtained from the China Research Data Service Platform (CNRDS) following the analysis of the patent classification number of listed companies. Subsequently, the resulting patent classification numbers correspond to the “Green List of the International Patent Classification” published by the World Intellectual Property Organization (WIPO) in 2010. Finally, the green patent data (including green invention patents and green utility model patents) are sorted out according to the matching results. The second part is the data of major shareholders. Considering that shareholders of listed companies may have kinship relationships and sign “acting in concert” agreements and other related relationships, persons acting in concert may be trained to vote on business decision-making issues. Therefore, this article refers to [29] the sum of the shareholding ratios of shareholders who form a group of persons acting in concert, and together calculate their shareholding ratios to determine whether they belong to the major shareholders defined in this paper. The data come from the China Stock Market & Accounting Research Database (CSMAR) and the annual reports of listed companies. The third part is the data

on enterprise characteristics, mainly from the China Stock Market & Accounting Research Database (CSMAR).

3.2. Variable Definition

3.2.1. Interpreted Variable: Green Innovation (Patent)

Green innovation is measured by the sum of the number of green invention patents and green utility model patents granted, mainly for the following reasons: First, the vehicle for transmitting environmental effects from green innovation is mainly a technical application, but the technical content of design patents is generally relatively limited, so design patents are not taken into account within in the scope of the variables of this article; second, not all application items can be granted, and the premise of being granted is to have certain standard scientific and technological achievements, so it is more appropriate to choose the number of grants.

3.2.2. Explanatory Variable: Multiple Major Shareholders

Due to differences in institutional backgrounds, the academic community has failed to reach a consensus on the definition of major shareholders. La Porta, R. et al. [52], Jiang, F. et al. [29] and others believe that only shareholders who hold 10% or more can be considered major shareholders. Judging from the actual situation in China, China's "Company Law" stipulates that one of the rights holders who proposes to convene an extraordinary general meeting has shareholders who individually or collectively hold more than 10% of the shares. Therefore, using 10% as the defining standard for major shareholders is reasonable and reliable. Further, shareholders of publicly traded companies may have kinship relationships, sign "acting-in-concert" agreements, and other related relationships to form persons acting in concert to vote on business decision-making matters. This article, referring to Jiang, F. et al. [29], summarizes the shareholder ratios of shareholders as a group of people acting in concert and calculate their shareholder ratios together to determine whether they are owned by major shareholders defined in this paper. This paper uses the dummy variables of multiple major shareholders (Multi) and the number of major shareholders (Nlarge) as the measurement indicators of multiple major shareholders.

3.2.3. Control Variable

Based on the existing research, the following variables are selected as the control variables in this paper, as shown in Table 1 below.

3.3. Model Setting

In order to test the hypothesis in this paper, the following models are constructed for testing:

$$\text{Patent}_{i,t} = \beta_0 + \beta_1 \text{Multi}_{i,t} + \text{Control} + \varepsilon \quad (1)$$

$$\text{Patent}_{i,t} = \beta_0 + \beta_1 \text{Nlarge}_{i,t} + \text{Control} + \varepsilon \quad (2)$$

Multi and Nlarge are the explanatory variables in model (1) and model (2), respectively, representing the dummy variables of multiple major shareholders and the number of major shareholders; the explained variables are both patent, indicating green innovation. i is the individual, t is the year, control is all the control variables, and ε is the random error term. Due to the "right-biased" nature of green innovation, the Tobit model is used for testing. If β_1 in model (1) and model (2) is significantly greater than 0, it means that the ownership structure of multiple major shareholders has a significant effect on green innovation.

Table 1. Variable Definition.

Variable Type	Variable Symbol	Variable Name	Variable Definition
Interpreted variable	Green innovation	Patent	The sum of the number of green invention patents and green utility model patents
Explanatory variable	Multiple major shareholders	Multi	Whether there are two or more major shareholders, the value is 1, otherwise it is 0
		Nlarge	The sum of the number of major shareholders holding 10% or more of the shares
Control variable	Enterprise Scale	Size	Natural logarithm of total assets
	Managerial ownership	Manager	Number of shares held by management/total shares
	Proportion of independent directors	Indd	Number of independent directors/total number of board of directors
	Board size	Board	Natural logarithm of board size
	Equity nature	Soe	1 for state-owned enterprises, 0 otherwise
	Combination of two duties	Dual	Take 1 when the chairman and general manager are concurrently held by the same person, otherwise take 0
	Asset-liability ratio	Lev	Total liabilities/total assets
Net interest rate on total assets	Roa	Year-end net profit/total assets	
Industry dummy variable	Ind		
Annual dummy variable	Year		

4. Empirical Analysis

4.1. Descriptive Statistics

The basic statistical characteristics of the variables in this paper are shown in Table 2 below. Among them, the maximum and minimum values of green innovation are 0 and 44, respectively, indicating a big difference in the number of green invention patents and green utility model patents held by the sampled companies. The average value of the innovation is 2.9581, meaning that the sampled firms hold on average three green invention and utility model patents per year. The average value of the dummy variables of multiple major shareholders is 0.2954, indicating that two or more shareholders are holding 10% of the shares in the sample companies, accounting for about 29.54%, which is similar to the results of Jiang, F. et al. [29]. The maximum and minimum number of major shareholders are one and four, respectively, while the median is one, indicating that more than half of the sample companies have a single major shareholder. The largest number of major shareholders can reach four. After exploring the mixed-ownership reform in China for many years, most enterprises developed a relatively balanced ownership structure in the ownership structure, and the phenomenon of “domination to a share” has gradually declined. Among the sample enterprises, the proportion of state-owned enterprises reached 34.77%. Descriptive statistics on other variables are similar to previous results.

Table 2. Descriptive Statistics.

Variable	N	Mean	SD	Min	p25	p50	p75	Max
Patent	28,859	2.9581	7.3921	0	0	0	2	44
Multi	28,859	0.2954	0.4562	0	0	0	1	1
Nlarge	28,859	1.3288	0.5853	1	1	1	2	4
Size	28,859	22.0780	1.2766	18.9394	21.1654	21.8989	22.7888	26.8230
Manager	28,859	14.2495	20.3590	0.0000	0.0003	0.6267	27.3173	69.5998
Indd	28,859	0.3748	0.0539	0.2500	0.3333	0.3333	0.4286	0.5714
Board	28,859	2.1298	0.1990	1.6094	1.9459	2.1972	2.1972	2.7081
Soe	28,859	0.3477	0.4762	0	0	0	1	1
Dual	28,859	0.2856	0.4517	0	0	0	1	1
Lev	28,859	0.4109	0.2084	0.0518	0.2433	0.4011	0.5639	1.2364
Roa	28,859	0.0371	0.0703	−0.4126	0.0150	0.0392	0.0691	0.2121

4.2. Regression Analysis

Model (1) and model (2) are used to test the influence of multiple major shareholders on green innovation, and the regression results are reported in Table 3 below. The explanatory variables in the first and second columns are the dummy variables of multiple major shareholders and the number of major shareholders, respectively. The regression coefficients passed the 1% and 5% significance level tests, respectively, and the coefficients are all positive numbers. This preliminarily confirms that the existence of the ownership structure of multiple major shareholders has a significant effect on promoting green innovation of enterprises. This preliminarily shows that the equity arrangement of multiple major shareholders has had a good corporate governance effect.

Table 3. The regression results of multiple major shareholders and green innovation.

Variable	(1)	(2)
	Patent	Patent
Multi	0.3623 *** (4.2816)	
Nlarge		0.1671 ** (2.5329)
Size	2.5265 *** (63.6765)	2.5296 *** (63.7439)
Manager	0.0102 *** (4.5248)	0.0102 *** (4.4991)
Indd	3.0447 *** (3.5388)	3.0703 *** (3.5680)
Board	−0.4207 * (−1.6914)	−0.3873 (−1.5572)
Soe	−0.2014 ** (−1.9899)	−0.2131 ** (−2.1059)
Dual	0.0784 (0.8647)	0.0768 (0.8464)
Lev	1.0444 *** (4.2778)	1.0236 *** (4.1913)
ROA	−1.5402 ** (−2.5038)	−1.5754 ** (−2.5608)
Constant	−55.5277 *** (−53.9877)	−55.7884 *** (−54.2952)
Industry	Control	Control
Year	Control	Control
Observations	28,859	28,859
Pseudo R ²	0.0380	0.0379

Note: ***, **, and * indicate passing the 1%, 5%, and 10% significance level tests respectively.

4.3. Mechanism Path Test of Multiple Large Shareholders Promoting Green Innovation: Cash Flow Fluctuation Level

The existence of multiple large shareholders forms a governance effect of mutual checks and balances and mutual supervision, which urges large shareholders to make more interest arrangement decisions in line with the long-term and stable development of the enterprise. In particular, it helps to improve the quality of corporate information disclosure and to reduce the potential for opportunistic management behaviour with the motivation of personal interest. At the same time, the equity arrangement of multiple large shareholders has a good restrictive effect on the overconfidence of the management, which can restrain the inefficient investment and blind expansion of the enterprise and reduce the fluctuation level of the enterprise's cash flow. The uncertainty inherent in the innovative activities of companies makes it more demanding in terms of sustainability and stability of funds. When the level of fluctuation in a company's cash flows increases, this is usually accompanied by complex changes in the external market. In this case, it

will be more difficult for the enterprise to predict its future operation, which will harm its internal capital stability. Based on the theory of liquidity preference, companies' preemptive liquidity opportunities encourage them to maintain higher cash flows to address environmental uncertainty and avoid falling into financial hardship [53]. Therefore, this paper believes that when multiple large shareholders inhibit the level of fluctuation in corporate cash flows, the level of corporate green innovation will increase. In order to verify this mechanism path, model (3) and model (4) are established successively on the basis of the above model (1). Based on model (2), model (5) and model (6) are established.

$$\text{Cfvol}_{i,t} = \beta_0 + \beta_1 \text{Multi}_{i,t} + \text{Control} + \varepsilon_{i,t} \quad (3)$$

$$\text{Patent}_{i,t} = \beta_0 + \beta_1 \text{Multi}_{i,t} + \beta_2 \text{Cfvol}_{i,t} + \text{Control} + \varepsilon_{i,t} \quad (4)$$

$$\text{Cfvol}_{i,t} = \beta_0 + \beta_1 \text{Nlarge}_{i,t} + \text{Control} + \varepsilon_{i,t} \quad (5)$$

$$\text{Patent}_{i,t} = \beta_0 + \beta_1 \text{Nlarge}_{i,t} + \beta_2 \text{Cfvol}_{i,t} + \text{Control} + \varepsilon_{i,t} \quad (6)$$

Among them, Cfvol is the level of fluctuation of cash flows, measured as the volatility over 3 years of the ratio of cash flows to total assets. The larger the index value, the higher the fluctuation level. Models (3) and (4) use OLS estimation, and models (5) and (6) use Tobit model. The regression results are shown in Table 4 below. In the first and third columns, the regression coefficients of multiple large shareholders on cash flow volatility (Cfvol) have passed the significance test of 1% level, and the coefficient is negative, indicating that the coexistence of multiple large shareholders can have a positive supervision effect, so as to reduce the excessive trust of managers such as indiscriminate expansion and to reduce the level of liquidity volatility. In the second and fourth columns, the regression coefficient of multiple large shareholders on green innovation is positive. The regression coefficient of cash flow volatility on green innovation is negative, both of which are significant at the level of 1%, indicating that cash flow volatility played a part in the intermediary effect in the path of multiple large shareholders affecting green innovation. The ownership structure of multiple large shareholders optimized the internal governance environment, and it reduces the level of fluctuation in companies' cash flows and at last increases enterprises' green innovation.

Table 4. Mechanism path test results of multiple large shareholders promoting green innovation.

Variable	Mechanism Path: Cash Flow Volatility			
	(1) Cfvol	(2) Patent	(3) Cfvol	(4) Patent
Multi	−0.0021 *** (−3.0827)	0.3518 *** (4.1561)		
Nlarge			−0.0017 *** (−3.3235)	0.1588 ** (2.4066)
Cfvol		−4.4043 *** (−4.2548)		−4.4577 *** (−4.3056)
Size	−0.0035 *** (−7.9862)	2.5094 *** (62.9439)	−0.0035 *** (−7.9794)	2.5123 *** (63.0060)
Manager	−0.0003 *** (−15.1323)	0.0091 *** (3.9907)	−0.0003 *** (−15.0931)	0.0090 *** (3.9612)
Indd	0.0067 (0.9225)	3.0460 *** (3.5414)	0.0066 (0.9152)	3.0712 *** (3.5702)

Table 4. Cont.

Variable	Mechanism Path: Cash Flow Volatility			
	(1)	(2)	(3)	(4)
	Cfvol	Patent	Cfvol	Patent
Board	−0.0082 *** (−3.5213)	−0.4633 * (−1.8614)	−0.0082 *** (−3.5305)	−0.4305 * (−1.7303)
Soe	−0.0034 *** (−3.2235)	−0.2149 ** (−2.1221)	−0.0033 *** (−3.2055)	−0.2266 ** (−2.2386)
Dual	−0.0026 *** (−3.5832)	0.0697 (0.7687)	−0.0026 *** (−3.5869)	0.068 (0.7493)
Lev	0.0389 *** (15.6230)	1.2083 *** (4.8899)	0.0388 *** (15.6100)	1.1894 *** (4.8121)
ROA	−0.0037 (−0.6831)	−1.5974 *** (−2.5970)	−0.0036 (−0.6649)	−1.6325 *** (−2.6538)
Constant		−54.8798 *** (−52.7986)	0.1374 *** (12.3714)	−55.1242 *** (−53.0708)
Industry	Control	Control	Control	Control
Year	Control	Control	Control	Control
Observations	28,859	28,859	28,859	28,859
Pseudo R ² /Adj_R ²	0.1936	0.0381	0.1941	0.0380

Note: ***, **, and * indicate passing the 1%, 5%, and 10% significance level tests respectively.

4.4. Analysis on the Regulation Mechanism of Multiple Large Shareholders Promoting Green Innovation

4.4.1. Green Finance

In order to cope with the increasingly severe environmental pressure and realize China's goal of carbon neutralization and carbon peak as soon as possible, green finance came into being as a specialized financial institutional arrangement. The institutional arrangement of green finance makes the financial sector fully consider the potential benefits and risks related to the environment when allocating funds. It is a guarantee system for the sustainable development of economy and society. This paper holds that green finance can play an important role in the green innovation of enterprises under the condition of controlling the equity of multiple large shareholders. The traditional financial sector will reasonably evaluate the benefits and risks of the project when making investment and funding decisions. Still, the environment is not taken into account as a necessary item. With the development of green finance, green innovation projects will get higher evaluation than general innovation projects, and then green innovation can get sufficient financial support in the face of financing constraints. In order to test the regulatory effect of Green Finance on the impact of multiple large shareholders on green innovation, the following model is constructed.

$$\text{Patent}_{i,t} = \beta_0 + \beta_1 \text{Multi}_{i,t} + \beta_2 \text{GF}^*_{i,t} + \beta_3 \text{Multi}_{i,t} + \text{Control} + \varepsilon_{i,t} \quad (7)$$

$$\text{Patent}_{i,t} = \beta_0 + \beta_1 \text{Nlarge}_{i,t} + \beta_2 \text{GF}^*_{i,t} + \beta_3 \text{Nlarge}_{i,t} + \text{Control} + \varepsilon_{i,t} \quad (8)$$

GF refers to green finance, which is calculated by entropy method. The data are mainly from China Statistical Yearbook, statistical yearbook of Chinese provinces, and China Insurance Yearbook. The evaluation system is shown in Table 5 below. Regression results from the green finance regulation mechanism for multiple large shareholders to promote green innovation are presented in Table 6 below. In the first and second columns, the regression coefficients of the interaction terms (GF*Multi, GF*Nlarge) between multiple large shareholders and green finance are significantly negative, which is contrary to the regression coefficients of multiple large shareholders (Multi, Nlarge). This indicates that the green financial system has a significant promoting effect on green innovation and

can form a complementary governance effect with the equity arrangement of multiple large shareholders.

Table 5. Green Finance Evaluation System.

Primary Index	Characterization Index	Indicator Description	Index Attribute
Green credit	Proportion of interest expense of high energy-consuming industries	Interest expense of six high energy-consuming industries/total industrial interest expense	-
Green investment	Proportion of investment in environmental pollution control in GDP	Investment in environmental pollution control/GDP	+
Green insurance	Depth of agricultural insurance	Agricultural insurance income/gross agricultural output value	+
Government support	Proportion of fiscal environmental protection expenditure	Financial environmental protection expenditure/financial general budget expenditure	-

4.4.2. Intellectual Property Protection

The new institutional economy believes that property rights can be an incentive, a moderator, and an allocation of resources [54], which all affect the decision-making of resource use and then play a role in economic performance. Previous studies have found a positive correlation between intellectual property protection and regional innovation performance [55]. When the intensity of intellectual property protection increases, enterprises can stably occupy and dispose of their innovative achievements. On the other hand, internalization of positive and negative externalities can improve innovation performance by reducing the spillover of research and development achievements. At the same time, it can raise the cost of enterprises and reduce the unexpected output of enterprises to pay great attention to green innovation. In order to test the regulatory effect of intellectual property protection on the impact of multiple large shareholders on green innovation, the following model is constructed.

$$\text{Patent}_{i,t} = \beta_0 + \beta_1 \text{Multi}_{i,t} + \beta_2 \text{Property}^*_{i,t} + \beta_3 \text{Multi}_{i,t} + \text{Control} + \varepsilon_{i,t} \quad (9)$$

$$\text{Patent}_{i,t} = \beta_0 + \beta_1 \text{Nlarge}_{i,t} + \beta_2 \text{Property}^*_{i,t} + \beta_3 \text{Nlarge}_{i,t} + \text{Control} + \varepsilon_{i,t} \quad (10)$$

The protection of intellectual property is measured by the application of the Patent Act by the patent authorities in each region. Property is equal to the patent non-infringement rate, one minus the number of patent infringement claims accepted by the Regional Intellectual Property Offices during the current year divided by the cumulative number of patents authorized in the province as of the current year. The higher the value of the index, the higher the degree of intellectual property protection. The regression results of the regulation mechanism of intellectual property protection on the promotion of green innovation by multiple large shareholders are reported in Table 6 below. In the third and fourth columns, the interaction coefficient between intellectual property protection and multiple large shareholders (Property*Multi, Property*Nlarge) is significantly negative, which is contrary to the regression coefficient of multiple large shareholders (Multi, Nlarge). This indicates that the protection of intellectual property has a major promotion effect on green innovation and can form a complementary governance effect with the equity arrangement of multiple large shareholders.

Table 6. Analysis results of regulatory mechanism for multiple large shareholders to promote green innovation.

Variable	Regulatory Effect: Green Finance		Regulatory Effect: Intellectual Property Protection	
	(1)	(2)	(3)	(4)
	Patent	Patent	Patent	Patent
Multi	0.5503 *** (3.9083)		0.5608 *** (4.7250)	
GF*Multi	−0.3422 * (−1.9540)			
GF	1.0080 *** (10.4454)	1.3876 *** (6.9720)		
Nlarge		0.3820 *** (3.4234)		0.3484 *** (3.6836)
GF*Nlarge		−0.3581 *** (−2.6042)		
Property*Multi			−0.4498 *** (−2.6792)	
Property			0.6843 *** (7.0342)	1.0643 *** (5.5096)
Property*Nlarge				−0.3809 *** (−2.9079)
Size	2.5159 *** (63.5298)	2.5175 *** (63.5527)	2.5368 *** (63.9321)	2.5397 *** (63.9967)
Manager	0.0072 *** (3.1839)	0.0072 *** (3.1646)	0.0084 *** (3.6791)	0.0083 *** (3.6439)
Indd	3.1015 *** (3.6126)	3.1269 *** (3.6419)	3.0054 *** (3.4961)	3.0267 *** (3.5204)
Board	−0.3489 (−1.4053)	−0.3187 (−1.2840)	−0.4225* (−1.6999)	−0.3924 (−1.5792)
Soe	−0.102 (−1.0058)	−0.1104 (−1.0890)	−0.1547 (−1.5266)	−0.166 (−1.6380)
Dual	0.0075 (0.0826)	0.0047 (0.0518)	0.0478 (0.5274)	0.0467 (0.5144)
Lev	1.2681 *** (5.1867)	1.2519 *** (5.1195)	1.0748 *** (4.4044)	1.0536 *** (4.3163)
ROA	−1.7115 *** (−2.7875)	−1.7465 *** (−2.8445)	−1.7561 *** (−2.8533)	−1.7935 *** (−2.9140)
Constant	−56.1770 *** (−54.6492)	−56.6338 *** (−54.9234)	−56.3416 *** (−54.4661)	−56.7802 *** (−54.8173)
Industry	Control	Control	Control	Control
Year	Control	Control	Control	Control
Observations	28,859	28,859	28,859	28,859
Pseudo R ²	0.0386	0.0386	0.0382	0.0382

Note: ***, ** and * indicate passing the 1%, 5%, and 10% significance level tests respectively.

4.5. Endogenous Problem Description and Robustness Test

First, build a double-difference model (DID) to estimate the difference of green innovation before and after the change of ownership structure of listed companies. The specific model is as follows:

$$\text{Patent}_{i,t} = \beta_0 + \beta_1 \text{Post}_{i,t} + \text{Control} + \varepsilon_{i,t} \quad (11)$$

Among them, the ownership structure changed from “single major shareholder” to “multiple major shareholders”, and the control group was “single major shareholder” in the observation years. The ownership structure changed from “multiple major shareholders” to “single major shareholder”. The control group was “multiple major shareholders” in the observation years. For the current year and subsequent years of equity change, the

value of post is one, and the value of the year before the change is zero. According to Table 7, when the ownership structure of listed companies changes from “single major shareholder” to “multiple major shareholders”, the net effect of ownership structure change (POST1) on green innovation is -0.5091 , which is significant at the level of 1%. When the ownership structure changes from “multiple major shareholders” to “single major shareholder”, the net effect of ownership structure change (post2) on green innovation is 0.3777 , which is significant at the level of 10%. The results show that the ownership structure changed from “single major shareholder” to “multiple major shareholders”, and the ownership arrangement of multiple major shareholders can promote green innovation. Second, to mitigate potential missing variables and two-way causation between multiple major shareholders and information disclosure offences, this paper used the two-stage instrumental variable method (2SLS) for endogenous testing. Referring to the research of Paligorova T. and Xu Z. (2012) [56] and Ben Nasr H. et al. (2015) [57], existing research adopts as an instrumental variable of the proportion of companies with multiple major shareholders in the same industry during the preceding year (multi_iv), because the ownership structure of enterprises is often related to the average ownership structure of the same industry in the previous year, but the level of green innovation has no effect on the ownership structure of the industry. The third and fourth columns are the regression results of the two-stage instrumental variable method, and the instrumental variable “Multi_IV” has a significant regression coefficient on multiple major shareholders, indicating that the instrument variables are correlated with the explanatory variables, and the instrumental variables are effective. The regression coefficient of multiple major shareholders to green innovation in the fourth column is significantly positive, which is consistent with the previous results, indicating that the empirical results of this paper are still stable after controlling the endogenous problem. Third, it is recommended to change the definition standard for major shareholders, change the definition standard for major shareholders to 5%, and trying again [58]. The results are also consistent with the foregoing as well.

Table 7. Robustness test results.

Variable	DID		Two-Stage Instrumental Variable Method		The Shareholding Ratio of Major Shareholders is Defined as 5%	
	Single to Multiple	Multiple to Single	(3)	(4)	(5)	(6)
	(1)	(2)	Multi	Patent	Patent	Patent
post1	-0.5091^{***} (-2.7626)					
post2		0.3777^* (1.8339)				
Multi_IV			0.2895^{***} (3.5155)			
Multi				14.8493^{***} (3.9451)		
Multi2					0.7179^{***} (9.1328)	
Nlarge2						0.2660^{***} (6.5612)
Size	2.4796^{***} (14.2941)	2.6550^{***} (12.0774)	0.0104 (1.2100)	2.3990^{***} (24.6962)	2.5296^{***} (63.8828)	2.5307^{***} (63.8659)

Table 7. Cont.

Variable	DID		Two-Stage Instrumental Variable Method		The Shareholding Ratio of Major Shareholders is Defined as 5%	
	Single to Multiple	Multiple to Single				
	(1)	(2)	(3)	(4)	(5)	(6)
	Patent	Patent	Multi	Patent	Patent	Patent
Manager	−0.0069 (−0.9683)	−0.0054 (−0.6478)	−0.0003 (−0.5786)	−0.0026 (−0.4597)	0.0093 *** (4.1281)	0.0093 *** (4.1102)
Indd	−2.3651 (−0.9727)	0.5646 (0.2216)	0.0865 (0.8870)	−2.7303 * (−1.8934)	3.0976 *** (3.6046)	3.1105 *** (3.6171)
Board	−1.9923 *** (−2.7537)	−1.0872 (−1.3972)	0.2130 *** (5.8581)	−4.9408 *** (−5.3646)	−0.5177 ** (−2.0824)	−0.4826 * (−1.9388)
Soe	0.3402 (0.8324)	0.3475 (0.6879)	0.0837 ** (2.4092)	−0.5275 (−1.1368)	−0.1188 (−1.1689)	−0.1497 (−1.4717)
Dual	−0.3213 ** (−2.1425)	−0.0473 (−0.2431)	−0.0087 (−0.8369)	−0.1062 (−0.7291)	0.0656 (0.7239)	0.0667 (0.7356)
Lev	−0.6136 (−1.1317)	0.5049 (0.7746)	−0.1829 *** (−4.6831)	2.3234 *** (2.7705)	1.0822 *** (4.4397)	1.0818 *** (4.4313)
ROA	−2.5786 *** (−3.6260)	−2.2299 *** (−2.7976)	−0.0855 * (−1.6513)	−1.113 (−1.3418)	−1.4680 ** (−2.3889)	−1.5022 ** (−2.4429)
Constant	−45.9700 *** (−10.9324)	−53.5150 *** (−10.2518)	−0.4512 ** (−2.0842)	−43.5117 *** (−15.6659)	−55.6453 *** (−54.2298)	−55.8984 *** (−54.4292)
Industry	Control	Control	Control	Control	Control	Control
Year	Control	Control	Control	Control	Control	Control
Observations	20,302	15,469	28,859	28,859	28,859	28,859
Pseudo R ² /Adj_R ²	0.1109	0.1175	0.0101	0.0546	0.0383	0.0381

Note: ***, **, and * indicate passing the 1%, 5%, and 10% significance level tests respectively.

5. Conclusions

Based on principal–agent theory, resource-based view, and institutional theory, this paper investigates the influence of multiple major shareholders on green innovation and its specific mechanisms, and discusses the situational variables of the two effects. The main conclusions are as follows: (1) The ownership arrangement of multiple major shareholders plays a good supervisory role and encourages green innovation in companies. (2) The equity arrangement of multiple major shareholders can alleviate the agency problem of enterprises, reduce the motivation of agents and controlling shareholders to seize private interests, and play an important role in limiting the level of fluctuation in companies' cash flows; in addition, the availability of funds plays a very important role in green innovation. In other words, multiple major shareholders can alleviate the fluctuation level of cash flow of enterprises and promote the green innovation of enterprises. (3) The existence of two formal systems, green finance and intellectual property protection system, can also enhance the green innovation of enterprises and effectively complement the informal system of multiple major shareholders' equity arrangement.

6. Practical Implication

Our findings have important ethical and practical implications for environmental management in China. First, managers recognize the benefits of introducing heterogeneous major shareholders for green innovation. With the acceleration of the non-marketable stock reform process, the types of shareholders of publicly traded companies in China are more diversified. At the same time, the phenomenon of “one dominant share” over the years has been effectively alleviated and the efficiency of corporate governance has been improved [59]. Managers continue to push for non-marketable stock reform to attract more large shareholders with different education backgrounds, professional backgrounds, and resources to the green innovation activities of listed companies.

Secondly, managers should be aware that the role of multiple major shareholders in green innovation will be affected by the institutional environment. The more complete the green financial system and the stronger the protection of intellectual property rights, the greater the degree of green innovation of enterprises. Therefore, managers should make full use of the benefits of social resources for the promotion of green innovation. For example, enterprises in regions with a sound green financial system can obtain financing more easily for projects related to environmental protection, which plays a good role in guaranteeing green innovation activities with a large demand for funds [60].

Our findings also have important implications for policy makers. First of all, decision-makers should realize that the introduction of heterogeneous major shareholders has a good mitigating effect on the controlling shareholders of publicly traded companies and the interested behaviour of management, so appropriate policies should therefore be developed to encourage enterprises to introduce heterogeneous and diversified main shareholders. Secondly, policy makers should also strengthen laws and regulations on corporate environmental management, provide certain financial subsidies or tax incentives to companies that dare to take responsibility for the environment, and take some punitive action against high-polluting companies. Then, policy makers should optimize the legal and regulatory environment, improve the effectiveness and authority of law enforcement, and change the chaotic situation in which enterprises arbitrarily violate environmental protection laws and regulations due to weak law enforcement and low pollution costs. Finally, policy makers can consider cooperating with relevant banks to enrich green financing channels, reduce the financing cost of green projects, and provide long-term stable funds for green projects to optimize the debt structure of enterprises, so as to encourage enterprises to carry out green innovation.

7. Limitations and Future Research

This study was subject to certain limits, which guide the research. First, the sample we used limited our findings in some ways. Our sample was selected as an industry-wide sample without distinguishing industry categories, and industrial institutions in different industries vary greatly. Companies in the service sector are susceptible to increased public regulatory pressure due to their exposure to consumers. In addition, we used listed companies, which enabled us to gather green innovation information from annual and social responsibility reports, but listed companies in China may be subject to stricter public scrutiny of environmental practices, and their behavior may be quite different from that of small and medium-sized private companies. Therefore, the reliability and repeatability of our results should be verified in different industry types of companies. In addition, our sample is limited to Chinese companies. Countries differ in economic development level, institutional environment, and corporate environmental practices [61]. Some developed countries have a long history of protecting the environment and strictly regulating. Therefore, from the perspective of samples, Chinese academics may consider the mechanism by which the ownership structure influences green innovation from the point of view of small and medium-sized enterprises, or select more enterprise samples from around the world to further analyze the influence mechanism of the ownership structure in different countries or regions on green innovation.

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