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Does Investor Sentiment Drive Corporate Green Innovation: Evidence from China

Li Dong *, Xin Zhang and Jinlong Chen

Department of Finance, Huaqiao University, Quanzhou 362021, China; zhangxxx08@126.com (X.Z.); jinlong@hqu.edu.cn (J.C.)
* Correspondence: dongli@hqu.edu.cn

Abstract: Green innovation plays an increasingly significant role in sustainable development. We use the data of Chinese listed firms from 2010 to 2019 to investigate the impact of investor sentiment on corporate green innovation. The result indicates that optimistic investor sentiment significantly promotes corporate green innovation. Mechanism analysis shows that the higher the financial constraints, institutional ownership ratio, and analyst coverage of a firm, the stronger the impact of investor sentiment on green innovation, indicating that optimistic investor sentiment promotes green innovation through external financing and managerial catering channels. In addition, the impact of investor sentiment on corporate green innovation is more pronounced for state-owned firms. The study sheds light on a novel determinant of corporate green innovation and offers policy recommendations to advance green innovation, environmental protection, and sustainable development.

Keywords: investor sentiment; green innovation; financial constraints; managerial catering; state ownership

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1. Introduction

With global warming and the increasingly severe destruction of the ecological environment, governments, firms, and social groups have begun to respond to environmental protection initiatives. The majority of countries are making an effort to combat global climate change. "Green" stands for the idea of sustainable development, which promotes the preservation of natural resources and the protection of the environment; "innovation" is the only way to get past obstacles to development and improve sustainability; and "green innovation" is the marriage of "green" and "innovation". In contrast to general innovation, green innovation incorporates pollution mitigation and resource conservation, supporting long-term economic growth and ecological preservation. It has emerged as a key tactic for businesses looking to cut pollution and conserve resources [1–3]. Companies that innovate in the green space are generally regarded as progressive and highly praised by the government, investors, and the media [4–6]. China, the nation that emits the most carbon dioxide and has the second-biggest economy in the world, has placed a greater emphasis on ecological conservation in recent years. The Chinese government made public a plan in September 2020 that aims to achieve "carbon peaking" and "carbon neutrality," highlighting the necessity of making large cuts to greenhouse gas emissions, particularly carbon dioxide. Carbon capture and sequestration, energy efficiency improvements, renewable energy technology, and the expansion of carbon sinks are all included in the category of green innovation. These cutting-edge technology developments are crucial for reducing carbon emissions and serve as key foundations that enable the realization of carbon neutrality goals. Studying the elements that promote green innovation and the green innovation of Chinese companies is therefore important. In the modern academic world, green innovation has also grown to be a prominent and much discussed topic. According to the *Chinese Green Patent Statistics Report*, colleges remain the primary source of green innovation in China, with corporations trailing behind, even though the country has made

significant progress in this area. This suggests that academics and industry in China are not collaborating enough to innovate in a synergistic way, which could impede the adoption of environmentally friendly inventions in the real world. According to the Triple Helix model, in order to promote scientific discoveries, knowledge production, and commercialization, government, business, and academia should interact dynamically within the innovation ecosystem [7]. Therefore, researching ways to increase businesses' involvement in green innovation is extremely important from a practical standpoint.

The stock market, known as the "barometer" of economic operation, is one of the major financial markets and a vital financing platform for firms, playing a significant role in economic development. Investor sentiment, reflecting market participants' investment inclinations and expectations, is a systematic bias concerning the anticipated direction of stock markets or individual firms [8], reflecting market participants' investment willingness or expectations. According to behavioral finance theory, because market participants are bounded rational, the investment decisions of stock market investors are often affected by sentiment, resulting in stock mispricing, which affects firms' financing and investment decisions [9,10]. Although technological innovation investment and physical investment have different attributes, investor sentiment nonetheless substantially impacts corporate innovation [11,12]; These documents found that optimistic investor sentiment promotes firms to increase research and development (R&D) investments and improve innovation level. However, will the positive effect of investor sentiment still exist if we narrow the scope of innovation to green innovation? There is no answer in the extant literature. In fact, the positive externalities associated with green innovation set it apart from general innovation [1,13]. Positive externalities in the context of green innovation are the benefits that flow from a company's eco-innovative actions outside of its immediate organizational boundaries. These benefits benefit society and the larger ecological system, all without requiring the beneficiaries to bear any costs in return. Green innovation generally refers to the development and use of innovative technologies, protocols, and product designs that are intended to lower emissions of pollutants, preserve resources, and improve energy efficiency. The consequent improvement in environmental circumstances results in numerous and diverse welfare advantages for society as a whole, which helps to maintain natural resources and raise living standards overall. General innovation reflects the imprinting of maximizing firm profit both in business philosophy and business practice, and it is easy to ignore the value of corporate environmental responsibility in the process of innovation; therefore, general innovation may lead to the imbalance between economic development, technological innovation, and ecological protection, and ultimately aggravate the contradiction between the infinity of technological expansion and the finiteness of resources, making the entire ecological environment gradually worsen and blocked economic development. High investor sentiment lowers stock issuance costs, encourages equity issuance, and increases enterprises' investment in innovation [14]. According to the managerial catering hypothesis [10], managers will cater to optimistic investor sentiment to invest in high-return but high-risk projects; thus, firms will carry out innovation investments when investor sentiment is high. However, we should also consider the following two possibilities: first, although optimistic investor sentiment provides firms with cheap financial capital, firms may not invest this financial capital in green innovation but invest this financial capital in general innovation projects; second, because green innovation has positive externalities, investors may prefer general innovation projects over green innovation projects, leading to managerial catering effect does not work. Therefore, whether investor sentiment significantly impacts corporate green innovation remains to be empirically examined.

We examine the influence of investor sentiment on corporate green innovation. Utilizing data from Chinese A-share listed firms, we conducted an empirical analysis and discovered that, after accounting for other variables affecting corporate green innovation, investor sentiment positively correlates with green innovation in the subsequent year, indicating that high investor sentiment promotes corporate green innovation. To affirm the robustness of our primary conclusion, we implemented several additional tests, in-

cluding the use of an instrumental variable, a propensity score matching (PSM) approach, alternative measures for green innovation and investor sentiment, and differentiation among patent types. Furthermore, we show that the impact of investor sentiment on green innovation intensifies with greater financial constraints, higher institutional ownership ratios, and increased analyst coverage; these factors hint at the alleviation of corporate financial constraints and managerial catering as potential mechanisms. We also explored the moderating role of state ownership, revealing that investor sentiment exerts a more substantial influence on green innovation in state-owned enterprises (SOEs) compared to non-state-owned enterprises (non-SOEs).

This paper has made at least three contributions. To begin with, this article examines how investor sentiment affects green innovation. We apply the bounded rationality theory to the idea of corporate green innovation, adding to the body of literature on the variables affecting green innovation. Secondly, the literature on behavioural finance is enhanced by this study. The effect of investor sentiment on business investment, corporate innovation, and corporate social responsibility has been studied in the past [9,10,15,16]. It did not, however, look at how investor opinion affected corporate green innovation. In this period of green development emphasis, we must comprehend the part that stock market investors' irrationality and faith play in green innovation. One of the important micro-foundations of economic green growth is corporate green innovation. This paper expands our understanding of this aspect. Third, from the perspective of the stock market governance mechanism, this paper explores the boundary conditions that investor sentiment impacts corporate green innovation, providing new light on the role of the stock market governance mechanism and state ownership in micro-level economic activities and providing more practical implications.

Although there has been prior study on green innovation in Chinese firms, it frequently ignores the possible influence of investor sentiment, which is a key factor influencing corporate investment decisions. The Chinese government has recently worked hard to improve the percentage of direct financing, especially through equity financing. Despite these initiatives, investor sentiment in the Chinese stock market has consistently shown a pessimistic trend over the past several years, leading to repeated calls from regulatory bodies for a revitalization of investor optimism and the equity market. We aim to explore whether there is a causal relationship between investor sentiment and corporate green innovation in China, where promoting green development and stimulating investor confidence are policy priorities. A notable observation is the predominance of retail investors in the Chinese stock market who, in contrast to institutional investors, may demonstrate greater emotional volatility and be less proactive in encouraging firms to align with societal expectations and environmental regulations [17]. Against the backdrop of rapid industrialization in China, which has led to significant environmental pollution, there is an urgent need for green transformations. Therefore, using rigorous empirical research, this study aims to empirically evaluate the effects of investor sentiment on corporate green innovation.

2. Literature Review and Hypothesis Development

2.1. Literature Review

According to behavioral finance theory, asset prices don't always fairly represent an asset's true value. Asset prices will fluctuate from their intrinsic values due to investor opinion, which will impact the firm's financing and investment choices. The market timing hypothesis [8] states that when a company's share price is undervalued or overvalued, management would repurchase (issue) additional shares, which will have an impact on the firm's investment choice. Baker et al. (2003) supposed the equity issuance channel hypothesis and held that positive investor sentiment encouraged firm investment by lowering equity cost [14]. Polk and Sapienza (2009) found that optimistic investor sentiment still influence the investments of companies that don't need issue shares; they supposed the managerial catering channel hypothesis [10]. The catering channel theory states that managers would raise their investments in high-risk but high-return initiatives in order to feed

positive market mood, sustain short-term stock values, and boost managers' income [10]. For instance, innovation investment has a higher risk than physical investment; however, if the invention proves effective, the firm's competitiveness may be quickly enhanced. As a result, corporations want to raise their innovation investment to boost investors' confidence in the firm's long-term value [18]. Someone investigated the relationship between market-level investor sentiment and corporate innovation; they found that high investor sentiment prompted firms to increase equity issuance and to use the financial capital obtained for innovation; they also found that high investor sentiment significantly improved innovation efficiency, enabling firms to produce a better patent portfolio [11]. Shen et al. (2021) also found that corporate innovation is related to equity issuance and managerial catering effect [12].

Existing literature indicates that green manufacturing and innovation carry substantial economic benefits. Green innovation can forge a firm's competitive edge, boosting its profitability and financial performance [19–24]. The extant research on the drivers of corporate green innovation predominantly revolves around four dimensions. The first category explores the influence of external pressures, such as environmental regulations, positing that stringent environmental laws and policies geared towards sustainability positively impact corporate green innovation [25–29]. This line of inquiry, grounded in neo-institutionalism and institutional economics, underscores the role of regulatory intensity. The second category is mainly based on the perspective of stakeholders; it believes that as a production unit with social attributes, the daily production and operation behavior of firms will have a significant impact on stakeholders; for instance, factors such as public oversight [30], pressures from suppliers, consumers, and competitors [31,32], collaborative green knowledge sharing in supply chains [33], and the environmental transparency of purchasing companies [34] are found to be pivotal in driving corporate green innovation. The third category focuses on the resource-based view, acknowledging the high costs and substantial resource requirements, including financial capital, for green innovation. Scholarly work in this area has examined how green financial policies bolster corporate green innovation by provisioning funds [35–37] and highlighted the critical role of knowledge resources [38,39]. The fourth category mainly studies the impact of organizational factors on corporate green innovation, such as state ownership [40], managers' attributes [41–43], corporate strategy [44], corporate culture [45,46], and corporate governance [47,48].

Prior research has solely examined how investor sentiment affects a firm's innovation; it has not examined how investor sentiment influences corporate green innovation. Many studies have shown the relationship between financial factors and green innovation. Yu et al. (2021) found that financial constraints impaired the capacity for green innovation, thereby reducing the output of green patents [49]. Xiang et al. (2022) investigated firms' preference for the sources of financial capital while engaging in green innovation and found that debt, equity, and subsidies all significantly impacted corporate green innovation, but the influence increased in turn [50]. Several researchers discovered that by easing financial constraints, digital finance encouraged firm green innovation [51,52]. Hu et al. (2021) found that green credit significantly improve green innovation in heavily polluting firms [35]. Han et al. (2022) found that green finance policy has significantly promoted corporate green innovation and that mitigating the debt financing constraints of firms is a transmission channel [36]. There is also some literature about how the stock market affects green innovation [53,54]. Surprisingly, although investor sentiment is a significant factor affecting stock market performance and corporate behavior, the extant literature does not include investor sentiment in the research framework of corporate green innovation.

2.2. Investor Sentiment and Corporate Green Innovation

The strategic decision-making process regarding a firm's green innovation activities is influenced by both internal motivations (innovation resources) and external environmental pressures (political forces) [55]. Based on the extant literature, we posit that investor sentiment impacts a firm's green innovation efforts through both these internal and external

forces. More specifically, positive investor sentiment may reduce a company's financing cost, which can boost its resources for green innovation and fortify its ability to innovate in this area. In an effort to appease investors, it may also inspire company management to explore green innovation.

Large investment and a protracted invention cycle are characteristics of green innovation [50,56]. Green innovation is devoted to reducing environmental pollution and has positive externalities, which increases additional innovation costs, making green innovation more costly and facing higher financial constraints than general innovation [51]. Constrained by the cost-effectiveness principle, firms carrying out quality management may focus more on formalized and standardized concepts and reduce green innovation to avoid risks and reduce costs [57]. Therefore, financial constraints are one of the significant constraints on corporate green innovation [49]. Some measures that can increase external financing and mitigate corporate financial constraints are conducive to promoting corporate green innovation [36,51,52]. In addition, the source of external financial capital will affect firm green innovation. The firm must repay the interest regularly and repay the principal on the maturity date of the debt while the financial capital is debt. However, innovation activity is a high-risk, long-cycle investment. Firms that use debt capital for innovation will increase the risk of debt default; moreover, compared with investors with a preference high-risk, creditors with a risk aversion tendency are more reluctant to see firms' high-risk innovation. Compared with loans or bonds, issuing equity may offer long-term, secure financial resources for innovation and promote corporate green innovation [50]. When a firm's market value is higher than its fundamental value, it is more probable for them to issue shares [58]. As optimistic investor sentiment can provide firms with cheap equity capital, rational managers will issue equity and increase capital expenditure [10,14], including innovation activities [11,12], when its stock is overpriced (i.e., when investor sentiment is optimistic). Therefore, positive investor sentiment will lower equity cost and thus improve firms' green innovation ability.

The impact of investor sentiment on corporate investment and innovation also originated from the managerial catering effect [12]. Optimistic sentiment among investors indicates that they have faith in the company's potential for future success. Managers will engage in some high-risk investment initiatives that investors favor to satisfy their positive expectations for the company and send out good signals that will preserve and even raise the firm's market value. However, is the catering channel hypothesis applicable to green innovation? It can be clear that green innovation has a high risk profile, which is a factor that optimistic investors are interested in. However, only when the investment project simultaneously has the characteristics of high return simultaneously the optimistic investors favor this investment project. Since the high innovation costs and positive externalities of green innovation will likely weaken the returns brought by innovation activities to firms, investors may expect firms to make something other than green innovations. Therefore, to determine whether investor sentiment influences corporate green innovation through a catering channel, the key point to determine is whether green innovation has excellent returns. From the extant literature, more evidence supports the positive side of green innovation on firm performance. Adhering to the concept of green development in the product design process can increase the differentiation advantages of products [59,60]. Green innovation can not only help firms establish a positive image and win a good reputation [59], but also help improve their market competitiveness, business performance, organizational performance, and financial performance [23,61–64]. Moreover, the government's policy orientation is a significant factor affecting investor sentiment; investors prefer industries and investment projects that the government encourages and supports and leads firm capital into relevant fields [15]. In the past two decades, governments worldwide have continuously emphasized green and sustainable development. Therefore, under the encouragement of government policies, firms carrying out green innovation may be favored by investors.

To sum up, we propose the following hypothesis:

H1. *Optimistic investor sentiment improves corporate green innovation.*

2.3. Potential Mechanism

2.3.1. External Financing Channel

Firms involved in green innovation rely on sustained large-scale capital investments, and those facing financial constraints may curtail their investment in such activities [49]. A theoretical model that describes how market-level investor sentiment might impact company innovation through financing channels was created by Dang and Xu (2018) [11]. According to their concept, a positive sentiment among investors may lower a company's cost of equity, ease financial pressures, and give more capital for innovation. Their empirical data supports this claim by showing that, in periods of strong market sentiment, financially strapped companies are more inclined to issue shares and then devote more resources to R&D. Therefore, if optimistic investor sentiment encourages green innovation in firms through outside financing, its beneficial impact on a company's green innovation initiatives will be more noticeable in organisations with more stringent budgetary constraints. This justification is easy to understand: Firms who don't do not have financial restrictions are already able to invest regularly in green innovation initiatives since they have enough cash and don't need an improvement in investor sentiment to secure the funding they need. Conversely, financially strapped companies can find it difficult to raise the money required for green innovation; in these situations, an improvement in investor mood effectively reduces the company's financing costs and offers more reasonably priced financing possibilities. Therefore, compared to enterprises with less financial constraints, the green innovation initiatives of financially restricted organisations are more susceptible to shifts in investor attitude. To test the financing mechanism, we propose the following hypothesis:

H2. *Financial constraints have a positive moderating effect on the relationship between investor sentiment and corporate green innovation.*

2.3.2. Managerial Catering Channel

Institutional investors and securities analysts play significant roles in the external governance mechanism of public companies. Institutional ownership and analyst coverage may moderate the effect of investor sentiment on firm green innovation if investor sentiment affects corporate green innovation through a managerial catering channel.

With the increasing popularity of the international community's requirements for corporate social responsibility, social responsibility has already become a significant basis for institutional investors to make investment decisions; this investment philosophy will be passed on to firms' managers and increase their motivation in corporate social responsibility fulfillment [65]. Rezende et al. (2019) found that the influence of green innovation on improving firm financial performance has a time lag and generally appears in the second year [66]. Institutional investors have more capital and better knowledge and skills than retail investors [67]. Institutional investors are more able to practice the long-term investment philosophy and endure short-term losses than retail investors; when the institutional ownership ratio is high, it is unlikely that managers will be dismissed due to short-term performance decline by innovation [68]. In order to obtain long-term benefits, institutional investors will require firms to engage in behaviors that conform to social expectations and environmental regulations [17]. Institutional investors' impact on corporate green innovation is subject to variation, as evidenced by recent scholarly investigations. A distinctive subset of these investors—characterized by their fortitude against external pressures—exerts a particularly pronounced and positive effect on fostering green innovation within firms [69]. It is worth emphasizing that this resilient group represents a significantly larger share of the institutional investor population compared to those who exhibit heightened sensitivity to pressures [69]. Therefore, it stands to reason that corporations boasting a greater institutional shareholder presence would likely align their strategies to accommodate these influential stakeholders, ultimately driving a more

robust and diversified agenda of green innovation initiatives. Therefore, if there are more institutional investors among the shareholders, managers will cater to these institutional investors to implement more green innovation. We have the following hypothesis:

H3. *Institutional ownership has a positive moderating effect on the relationship between investor sentiment and corporate green innovation.*

Green innovation has the characteristics of high innovation costs and positive externalities; therefore, only when investors can fully realize the positive value that green innovation brings to firms, rather than simply thinking that green innovation wastes the bounded resources of firms, will investors give a positive evaluation to firms carrying out green innovation [70]. However, most investors, particularly retail investors, are weak in information collection and mining [67]. Analysts are professionals who study the value of the stock investment and are good at mining valuable information that ordinary investors cannot find from a variety of complex information [71]; they are an important information medium in the stock market and help to enhance information transparency and alleviate agency problem [72–74]. Luo et al. (2015) found that since analysts pay attention to corporate social responsibility performance and take it as one of the bases for investment recommendations, analyst recommendations play an intermediary role between corporate social responsibility performance and market performance [67]. Due to analysts' significant role in improving the stock market's information efficiency, investors can better understand the long-term value of corporate green innovation [70]. In the face of external pressure, firms with rich resources are more likely to invest necessary human resources and financial capital to implement green innovation [75]. Therefore, if more analysts cover the firm, investors will recognize its green innovation activities more, and managers will carry out more green innovation activities. We have the following hypothesis:

H4. *Analyst coverage has a positive moderating effect on the relationship between investor sentiment and corporate green innovation.*

2.4. State Ownership

SOEs in emerging markets and transitional economies are important executors of national economic policies [76,77]. State ownership may moderate the effect of investor sentiment on corporate green innovation from opposite directions.

In accordance with institutional theory, state ownership can be perceived as a compensatory mechanism for deficiencies in market institutions [78]. In emerging economies like China, the symbiotic political relationship grants SOEs privileged access to a broader spectrum and preferential allocation of critical resources, such as bank loans, land, and industry permits [79–82]. Such access is positively associated with SOEs' ability to initiate and perpetuate green innovation endeavors. When it comes to financing green innovation, non-SOEs face significantly more daunting obstacles in acquiring green financing from financial institutions compared to their state-owned counterparts [49]. Consequently, from a resource dependency standpoint, non-SOEs, lacking sufficient and economical resources, become more sensitive to the volatility of external resource availability when considering green R&D investments and strategies. Thus, given the substantial influence of investor sentiment on equity financing costs, the green innovation decisions of non-SOEs tend to react be more to changes in investor sentiment compared to those of SOEs. It suggests that state ownership may negatively moderate the influence of investor sentiment on green innovation, as non-SOEs are more vulnerable to changes in financing conditions driven by sentiment.

However, SOEs serve political as well as economic objectives, with political objectives taking precedence. Political goals emphasize that firms should serve national policies [79]. Green development is the direction advocated and encouraged by the government and has significant ecological and social values. SOEs dominated by political goals must share

the government's social responsibility [83] and help the government implement the green development strategy; they are the critical executors of the government to promote green innovation [40]; as a result, SOEs must make large financial input to improve their capacity for green innovation. However, borrowed financing is inappropriate for R&D investment due to its nature. Green innovation may be fostered by the issuing of equity, which can provide steady, long-term finance for R&D [50]. Furthermore, in order to maintain the socialist framework, the Chinese government continuously emphasises how crucial it is to maintain state ownership's dominating position in the economy. To this end, the state must remain the majority shareholder in SOEs and ensure that excessive state ownership dilution is avoided. Positive market sentiment gives SOEs a chance to reduce equity costs, promote environmental protection objectives, and lessen the diluting effect of state control while issue equity issuance. Therefore, in an environment where investor sentiment is higher, SOEs could be more inclined to explore green innovation. Previous studies also show that elements that may lower external financing costs and improve external financing capabilities—such as digital finance and green credit—have a more positive influence on SOEs' green innovation than on non-SOEs' green innovation [35,51].

Therefore, we propose two opposite hypotheses to be tested:

H5a. *State ownership negatively moderates the relationship between investor sentiment and corporate green innovation.*

H5b. *State ownership positively moderates the relationship between investor sentiment and corporate green innovation.*

The conceptual framework is shown in Figure 1.

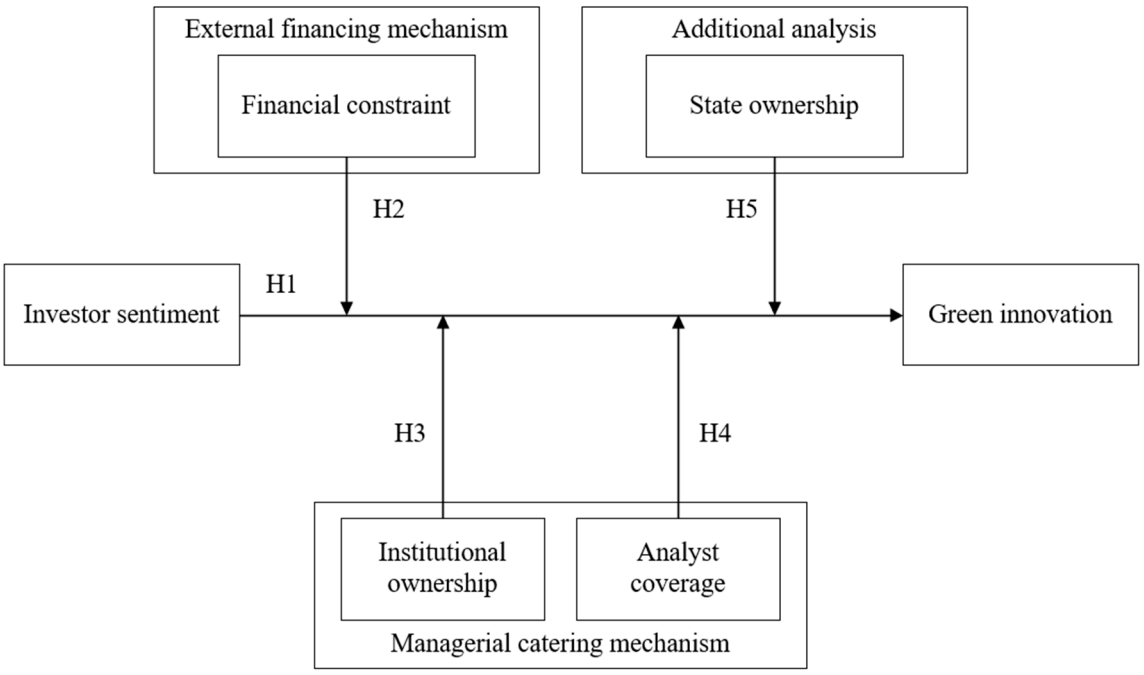

Figure 1. Conceptual framework.

3. Research Design

3.1. Sample and Data

The sample of this paper is from the listed firms in China's A-share stock market, with the observation window of 2010–2019, and the data is obtained from the CSMAR database. Financial industries, observations in the initial public offering year and the following year, and observations with missing variables were excluded. Eventually, our research obtained

23,002 firm-year observations encompassing 3375 firms across 45 industries, with 2161 firms and 13,941 firm-year observations in various manufacturing sectors, and 1214 firms with 9061 firm-year observations in non-manufacturing sectors.

3.2. Measurement of Variables

3.2.1. Dependent Variable

Existing literature measures firm innovation by the patent granted or applications. During the patent application period, temporarily ungranted patents can still be used for the firm's production, which will substantially impact the operation and performance of firms. Following Fang et al. (2014) [84], we gauge a firm's green innovation level by determining the annual number of green patent applications that are ultimately granted. Additionally, we employ the annually granted green patents to make robustness check.

The original data on green patents are from the World Intellectual Property Organization (WIPO). By matching the IPC classification codes of each patent with the International Patent Classification Green List maintained by WIPO, the CSMAR database was able to identify green patents. As a result, we obtained corporate green patent data straight from the CSMAR database. These patents cover a wide range of topics, including transportation, waste management, and energy saving. Since the development and application of design patents are the most easily manipulated patent types, we exclude green design patents and only include green invention patents and utility patents.

3.2.2. Independent Variable

Extant literature shows market- and firm-level proxy variables for investor sentiment. Given the neglect of cross-sectional differences in investor sentiment by market-level proxy, we chose a firm-level proxy variable. The stock mispricing component is obtained by decomposing a firm's market-book ratio [85], and we use it to measure firm-level investor sentiment. Since investor sentiment fluctuates frequently, we measure it using quarterly data.

3.2.3. Moderating Variable

Financial constraints. It is measured by the SA index [86]. The SA index's endogeneity issue is lower than other measurement indicators.

Institutional ownership. It is measured by shares held by institutional investors in the firm.

Analyst coverage. It is measured by the number of analysts following a firm in a year. Following To et al. (2013) [87], if an analyst publishes at least one tracking report about a firm in a year, we include that analyst.

State ownership. It is measured by a dummy variable.

3.2.4. Control Variable

We control for firm size, age, leverage, profitability, growth, asset structure, cash flow, and ownership concentration, the independence of the board, and state ownership.

The specific definitions of the above variables are represented in Table 1.

Table 1. Variable Definition.

Variable	Symbol	Definition
Green innovation	*Green*	Logarithm of one plus the number of green patent applications in that year that are ultimately granted
Investor sentiment	*IS*	Stock mispricing obtained by decomposing the market-book ratio
Financial constraints	*FC*	SA index, SA= $-0.737 \times Size + 0.043 \times Size^2 - 0.04 \times Age$
Institutional ownership	*IO*	Shares held by institutional investors/Total shares
Analyst coverage	*AC*	Logarithm of one plus the number of analysts following a firm in a year
State ownership	*SOE*	If the firm is a SOE, *SOE* equals 1; otherwise, *SOE* equals 0.
Size	*Size*	Logarithm of total assets

Table 1. *Cont.*

Variable	Symbol	Definition
Age	*Age*	Logarithm of firm age
Leverage	*Lev*	Total liabilities/total assets
Profitability	*ROA*	Net profits/total assets
Growth	*Grow*	Revenue growth rate
Asset structure	*Fix*	Net fixed assets/total assets
Cash flow	*CF*	Operating cash flow/total assets
Ownership concentration	*Top*	The largest shareholder's shares/total shares
Independence of the board	*ID*	Number of independent directors/number of directors

3.3. Empirical Model

We establish a model to examine the impact of investor sentiment on enterprise green innovation:

$$Green_{i,t} = \alpha_0 + \alpha_1 IS_{i,t-1} + \alpha \sum X_{i,t-1} + Ind + Year + \varepsilon \quad (1)$$

We also establish a moderating effect model:

$$Green_{i,t} = \beta_0 + \beta_1 IS_{i,t-1} + \beta_2 IS_{i,t-1} \times M_{i,t-1} + \beta_3 M_{i,t-1} + \beta \sum X_{i,t-1} + Ind + Year + \varepsilon \quad (2)$$

where *M* represents the moderating variable; in specific regression, *M* can represent financial constraints (*FC*), institutional ownership (*IS*), analyst coverage (*AC*), and national ownership (*SOE*); *X* represents the control variable; and *Ind* and *Year* represent industry- and time-fixed effects, respectively. Considering that the transition from innovation input to innovation output takes a long time, as well as to alleviate endogeneity, we lag the variables on the right side of the model by one period.

4. Empirical Analysis

4.1. Descriptive Statistics

Table 2 reports the descriptive statistics of the variables. The mean value of *Green* stands is 0.686, with a median of 0, which aligns with the extant literature [36]. *Green*'s standard deviation is 1.037, highlighting the variability in green innovation levels among firms. Our statistical analysis of green patents reveals an average of 5.11 green patents filed per firm annually, corroborating the findings of prior studies [88,89]. The mean and standard deviation of *IS* are 0.043 and 0.394, respectively, indicating significant fluctuations and cross-sectional differences in investor sentiment.

Table 2. Descriptive Statistics.

Variable	Mean	SD	Min	Median	Max
Green	0.686	1.037	0	0	4.263
IS	0.043	0.394	−0.728	0.003	1.210
FC	−3.733	0.241	−4.317	−3.740	−3.086
IO	0.408	0.249	0	0.424	0.896
AC	1.496	1.153	0	1.386	3.714
SOE	0.413	0.492	0	0	1
Size	22.08	1.289	19.48	21.92	26.02
Age	2.317	0.646	1.099	2.398	3.258
Lev	0.444	0.213	0.053	0.439	0.929
ROA	0.035	0.059	−0.248	0.034	0.191
Grow	0.214	0.563	−0.594	0.116	4.070
Fix	0.225	0.168	0.002	0.190	0.719
CF	0.041	0.073	−0.191	0.041	0.245
Top	0.350	0.149	0.091	0.330	0.750
ID	0.374	0.053	0.333	0.333	0.571

4.2. Baseline Regression Result

Table 3 shows the regression results of model (1). The independent variable in column (1) only includes investor sentiment (*IS*), and the coefficient is significantly positive ($\alpha_1 = 0.182$, $p < 0.01$). Control variables were progressively introduced in columns (2) and (3), and the coefficient is stays significant ($\alpha_1 = 0.171$, $p < 0.01$; $\alpha_1 = 0.127$, $p < 0.01$). The regression result indicate that high investor sentiment promotes corporate green innovation, supporting hypothesis H1.

Table 3. Baseline Regression Result.

	(1)	(2)	(3)
	Green	***Green***	***Green***
IS	0.182 ***	0.171 ***	0.127 ***
	(0.016)	(0.015)	(0.017)
Size		0.338 ***	0.344 ***
		(0.007)	(0.006)
Age		−0.250 ***	−0.115 ***
		(0.012)	(0.011)
Lev		0.064 *	0.134 ***
		(0.035)	(0.034)
ROA		0.192 *	0.721 ***
		(0.108)	(0.106)
Grow		−0.016	−0.004
		(0.011)	(0.010)
Fix		−0.115 ***	−0.133 ***
		(0.040)	(0.041)
CF		−0.209 **	−0.036
		(0.088)	(0.078)
Top		−0.382 ***	−0.152 ***
		(0.047)	(0.042)
ID		0.202	−0.071
		(0.126)	(0.110)
SOE		0.008	0.069 ***
		(0.015)	(0.014)
_cons	0.678 ***	−6.158 ***	−6.973 ***
	(0.007)	(0.147)	(0.137)
Ind	No	No	Yes
Year	No	No	Yes
N	23,002	23,002	23,002
R *	0.005	0.159	0.343

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. Standard errors are in parentheses.

Regarding the control variables, firm size (*Size*), leverage (*Lev*), and profitability (*ROA*) positively impact green innovation, which is easy to understand: Larger firms have comparative advantages in financial capacity, labor quality, and other aspects; Profitable firms are better equipped to devote more capital; and firms with higher leverage have stronger external financial capacity. Moreover, the coefficient of state ownership (*SOE*) is significant and positive, indicating that green innovation is more likely to come from SOEs. The previous literature [36,88–90] largely agrees with the control variables' coefficients and significance; sample variations may account for certain variables' coefficient discrepancies. To sum up, the fundamental explanatory variable (*IS*) that we are interested in has a positive coefficient.

4.3. Moderating Effect

Firms engaging in green innovation rely on sustained large-scale capital investment. Therefore, if the external financing channel exists, we expect that when the firm's financial constraints are higher, optimistic investor sentiment will have a more pronounced positive effect on green innovation. We use the moderating effect model to test external financing channels. The regression result is reported in column (1) of Table 4; investor sentiment (*IS*) and financial constraints (*FC*) have an interaction term with a coefficient that is significantly

positive (β_2 = 0.285, $p < 0.01$), indicating that the effect of investor sentiment on firm green innovation increases with the increase of financial constraints, supporting hypothesis H2. This result shows the existence of external financing channels.

Table 4. Moderating effect.

	Financial Constraint	Institutional Ownership	Analyst Coverage	State Ownership
	(1) *Green*	(2) *Green*	(3) *Green*	(4) *Green*
IS	0.087 ***	0.131 ***	0.098 ***	0.085 ***
	(0.016)	(0.017)	(0.017)	(0.019)
IS × *FC*	0.285 ***			
	(0.059)			
IS × *IO*		0.117 **		
		(0.058)		
IS × *AC*			0.029 **	
			(0.013)	
IS × *SOE*				0.121 ***
				(0.030)
Size	0.332 ***	0.345 ***	0.305 ***	0.342 ***
	(0.006)	(0.006)	(0.007)	(0.006)
Age	−0.041 ***	−0.112 ***	−0.089 ***	−0.112 ***
	(0.012)	(0.011)	(0.011)	(0.011)
Lev	0.157 ***	0.134 ***	0.169 ***	0.134 ***
	(0.034)	(0.034)	(0.034)	(0.034)
ROA	0.872 ***	0.731 ***	0.370 ***	0.745 ***
	(0.105)	(0.105)	(0.107)	(0.105)
Grow	−0.002	−0.004	−0.002	−0.004
	(0.010)	(0.010)	(0.010)	(0.010)
Fix	−0.157 ***	−0.131 ***	−0.126 ***	−0.128 ***
	(0.041)	(0.041)	(0.041)	(0.041)
CF	−0.047	−0.033	−0.116	−0.031
	(0.078)	(0.079)	(0.079)	(0.079)
Top	−0.174 ***	−0.128 ***	−0.118 ***	−0.150 ***
	(0.042)	(0.045)	(0.042)	(0.042)
ID	−0.162	−0.082	−0.045	−0.067
	(0.109)	(0.110)	(0.110)	(0.110)
SOE	0.068 ***	0.073 ***	0.080 ***	0.066 ***
	(0.014)	(0.014)	(0.014)	(0.014)
FC	0.400 ***			
	(0.032)			
IO		−0.040		
		(0.028)		
AC			0.069 ***	
			(0.006)	
_cons	−5.436 ***	−6.993 ***	−6.348 ***	−6.937 ***
	(0.163)	(0.140)	(0.151)	(0.137)
Ind	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes
N	23,002	23,002	23,002	23,002
R *	0.349	0.343	0.346	0.343

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. Standard errors are in parentheses.

Institutional investors and securities analysts play significant roles in the stock market and are an essential part of the external governance mechanism of public firms. If the managerial catering channel exists, we expect that when the firm's institutional ownership and analyst coverage are higher, optimistic investor sentiment will have a more pronounced positive effect on its green innovation. The results are reported in columns (2) and (3) of Table 4, which shows that investor sentiment (*IS*) and institutional ownership (*IO*) have an interaction term with a coefficient that is significantly positive (β_2 = 0.117, $p < 0.05$) and that the coefficient of the interaction term between investor sentiment (*IS*) and analyst coverage

(*AC*) is also significantly positive ($\beta_2 = 0.029$, $p < 0.05$), supporting hypotheses H3 and H4. These results show the existence of managerial catering channels.

We use the moderating effect model to investigate the role of state ownership. The regression result is shown in column (4) of Table 4; investor sentiment (*IS*) and state ownership (*SOE*) have an interaction term with a coefficient that is significantly positive ($\beta_2 = 0.121$, $p < 0.01$), indicating that investor sentiment has a more pronounced effect on green innovation in SOEs, supporting hypothesis H5b rather than hypothesis H5a. The cause may be that SOEs have to take on more social responsibilities and have a stronger motivation for green innovation; with the tailwind generated by high investor sentiment, SOEs can not only promote the realization of the political goal of protecting the environment, but also lower financing costs and alleviate the dilution of state ownership caused by issuing equity.

5. Robustness Test

5.1. Instrumental Variable

We construct instrumental variables based on the weather in the location of the stock exchange. Evidence suggests a correlation between the weather in the city of the stock exchange and investor sentiment [91,92]. Therefore, the weather in the location of the stock exchange meets the requirements of correlation and exclusivity, and there is no evidence to suggest that the weather in the location of the stock exchange directly affects corporate green innovation. The instrumental variable passed the under-, weak-, and over-identification test. The regression result of the second stage of 2SLS is shown in column (1) of Table 5; the coefficient of *IS* remains significant ($\alpha_1 = 0.120$, $p < 0.01$).

Table 5. Robustness test.

	(1) *Green*	(2) *Green*	(3) *Green*	(4) *Green*	(5) *Green*	(6) *Green*	(7) *GreenN*	(8) *GreenI*	(9) *GreenU*
IS	0.120 ***	0.125 ***	0.186 ***	0.108 ***	0.027 ***	0.086 **	0.100 **	0.148 ***	0.080 ***
	(0.022)	(0.023)	(0.017)	(0.016)	(0.009)	(0.039)	(0.044)	(0.011)	(0.015)
Size	0.342 ***	0.341 ***	0.334 ***	0.334 ***	0.341 ***	0.704 ***	0.790 ***	0.200 ***	0.289 ***
	(0.007)	(0.009)	(0.007)	(0.006)	(0.006)	(0.013)	(0.015)	(0.005)	(0.006)
Age	−0.140 ***	−0.094 ***	−0.149 ***	−0.086 ***	−0.114 ***	−0.339 ***	−0.291 ***	−0.051 ***	−0.100 ***
	(0.013)	(0.015)	(0.013)	(0.010)	(0.011)	(0.025)	(0.028)	(0.007)	(0.010)
Lev	0.127 ***	0.108 **	0.166 ***	0.104 ***	0.157 ***	0.243 ***	0.351 ***	−0.069 ***	0.190 ***
	(0.036)	(0.046)	(0.035)	(0.032)	(0.034)	(0.087)	(0.094)	(0.021)	(0.031)
ROA	0.786 ***	0.757 ***	0.948 ***	0.292 ***	0.815 ***	2.222 ***	2.190 ***	0.119 *	0.632 ***
	(0.109)	(0.148)	(0.125)	(0.102)	(0.105)	(0.296)	(0.326)	(0.063)	(0.097)
Grow	−0.009	0.002	−0.019 *	−0.033 ***	0.001	−0.003	−0.041	−0.013 **	−0.002
	(0.010)	(0.014)	(0.010)	(0.009)	(0.010)	(0.024)	(0.029)	(0.006)	(0.009)
Fix	−0.107 **	−0.085	−0.121 ***	−0.116 ***	−0.163 ***	−0.323 ***	0.009	−0.158 ***	−0.051
	(0.043)	(0.057)	(0.043)	(0.039)	(0.041)	(0.103)	(0.117)	(0.026)	(0.038)
CF	−0.039	0.025	0.094	−0.019	−0.023	−0.304	0.037	0.156 ***	−0.128 *
	(0.082)	(0.108)	(0.081)	(0.076)	(0.078)	(0.210)	(0.240)	(0.048)	(0.072)
Top	−0.133 ***	−0.132 **	−0.143 ***	−0.112 ***	−0.138 ***	−0.326 ***	−0.450 ***	−0.072 ***	−0.104 ***
	(0.044)	(0.059)	(0.043)	(0.040)	(0.042)	(0.095)	(0.105)	(0.028)	(0.038)
ID	−0.074	0.032	0.067	−0.067	−0.018	−0.611 **	0.155	0.303 ***	−0.088
	(0.116)	(0.153)	(0.118)	(0.104)	(0.110)	(0.239)	(0.257)	(0.075)	(0.101)
SOE	0.076 ***	0.057 ***	0.069 ***	0.047 ***	0.064 ***	0.161 ***	0.038	0.082 ***	0.034 ***
	(0.015)	(0.020)	(0.015)	(0.014)	(0.014)	(0.033)	(0.036)	(0.009)	(0.013)
_cons	−6.886 ***	−7.021 ***	−6.715 ***	−6.860 ***	−6.526 ***	−15.816 ***	−17.520 ***	−4.095 ***	−5.985 ***
	(0.145)	(0.188)	(0.145)	(0.132)	(0.155)	(0.290)	(0.327)	(0.106)	(0.127)
Ind	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Year	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
N	20,978	12,097	21,432	23,002	23,002	23,002	23,002	23,002	23,002
R *	0.349	0.350	0.340	0.344	0.341	0.162	0.111	0.246	0.334

*** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. Standard errors are in parentheses.

5.2. Propensity Score Matching

We use the PSM approach to treat the samples to alleviate endogeneity further. Specifically, the samples are firstly grouped based on the mean value of *IS*; then, all control variables are treated as covariates, and the samples are matched through the 1:1 nearest neighbor matching approach; finally, the matched samples are used to re-test the model (1). The regression result is shown in column (2) of Table 5, and the coefficient of *IS* is significant ($\alpha_1 = 0.125$, $p < 0.01$).

5.3. Re-Measuring the Green Innovation and the Investor Sentiment

First, considering the lengthy innovation process, we adjusted the independent variable lagged by a year in the baseline regression to lagged by two years; the regression result ($\alpha_1 = 0.186$, $p < 0.01$) is shown in column (3) of Table 5.

Second, we use the logarithm of one plus the number of green patents that are granted in that year as the dependent variable to re-test the model (1); the regression result ($\alpha_1 = 0.108$, $p < 0.01$) is shown in column (4) of Table 5.

Third, following [93], we construct market-level investor sentiment indicators and re-test the model (1); the regression result ($\alpha_1 = 0.027$, $p < 0.01$) is shown in column (5) of Table 5.

5.4. Replace the Regression Model

We use the Tobit regression model to re-examine the model (1). The regression result is represented in column (6) in Table 5, and the coefficient of *IS* is still significant and positive ($\alpha_1 = 0.086$, $p < 0.05$).

We also use the original value of the number of green patent applications as the dependent variable (*GreenN*) and the negative binomial regression model (NB) to estimate. The NB is suitable for the discrete dependent variable. The regression result ($\alpha_1 = 0.100$, $p < 0.05$) is represented in column (7) in Table 5.

5.5. Distinguish Patent Types

Utility and innovation green patents differ in their application difficulty, cost, and economic benefits. Generally speaking, the application difficulty, technical value, cost, and protection time of invention patents are greater than those of utility patents. Because some firms have bounded innovation capabilities, to obtain certain benefits, the firm's managers usually carry out a "speculative innovation". Such innovation only reflects the speed and quantity of firm innovation and does not represent firms' competitiveness and actual innovation capabilities. A worry is whether firms will cater to investor sentiment through low-quality green innovation. Does high investor sentiment only promote low-quality green innovation? Columns (8) and (9) in Table 5 represent the regression results of different types of green patents, respectively; it can be seen that whether the dependent variable is a green invention patent (*GreenI*) or green utility patent (*GreenUI*), the coefficient of *IS* is always significant and positive ($\alpha_1 = 0.148$, $p < 0.01$; $\alpha_1 = 0.080$, $p < 0.01$).

6. Conclusions and Discussion

6.1. Conclusions

The preservation of the natural environment and sustainable economic development depend heavily on green innovation. This is especially important for emerging nations that are rapidly industrialising. This research empirically explores how investor sentiment affects firm green innovation. Using financial records of Chinese listed firms from 2010 to 2019 and data on green patents, the following conclusions are drawn:

(1) The optimistic investor sentiment exerts a positive influence on firm green innovation. This conclusion's robustness has been confirmed through a variety of tests.
(2) Mechanistic analysis shows that investor sentiment propels corporate green innovation via external financing and managerial catering channels. Positive investor sentiment facilitates access to the financial capital required for green innovation and

aids companies in surmounting fiscal constraints associated with these endeavors. During periods of high sentiment, green innovation satisfies investors' pursuit of high-risk but high-return projects, prompting managers to cater to these preferences and bolstering firms' resolve to pursue green innovation. Both institutional ownership and analyst coverage can amplify the positive impact of investor sentiment on corporate green innovation. Institutional investors prioritise long-term returns and corporate environmental performance, while analyst coverage can increase firms' information transparency and lessen the information asymmetry that exists between investors and managers. Together, these two external governance mechanisms can increase managerial pressure and incentives to pursue green innovation.

(3) Additional investigation has shown that the relationship between investor sentiment and green innovation is favourably moderated by state ownership. One explanation might be that SOEs have political incentives to support green development policies and are key players in driving green innovation. Because of this, SOEs need to invest a lot of money, especially in equity, to strengthen their capacity for green innovation. Positive investor mood offers SOEs a chance to advance environmental conservation objectives, reduce equity costs, and lessen the diluting effect of issuing shares on national ownership.

6.2. Theoretical Contribution

First, this study enriches the discourse on the determinants of such innovation by applying the bounded rationality hypothesis from behavioral finance to firm green innovation. Previous studies have focused on objective factors like environmental regulations [25–29] and external resources [35,36] on firm green innovation. The psychological viewpoint of managers has been examined in certain publications when examining the determinants of firm green innovation [41,42,88]. This paper adds to the research on firm green innovation from the standpoint of investor psychology.

Second, although the link between investor sentiment and firm innovation has been investigated in the past [11,12], we acknowledge that green innovation faces externalities that are not present in general innovation, which might result in more substantial resource restrictions. Thus, this paper adds to the body of knowledge on the relationship between investor sentiment and corporate innovation by extending the research on the impact of investor sentiment on firm innovation to the study of the impact of investor sentiment on firm green innovation, drawing on earlier research.

Third, prior research has examined state ownership [40] and corporate external governance methods [69,70]. We further incorporate these factors—based on previously published research—into the framework for studying the relationship between investor sentiment and firm green innovation. We investigate the conditions that limit investor sentiment's impact on green innovation from the standpoints of external corporate governance mechanisms and state ownership, offering fresh perspectives on the functions of state ownership and stock market governance mechanisms.

6.3. Practical Implication

According to the research conclusion, we can draw some practical implications:

First, despite the negative effects of excessive optimism on investor sentiment [10,94,95], optimistic investor sentiment is beneficial for encouraging corporate innovation and green innovation. Governments should properly acknowledge the role that the stock market and investor sentiment play in promoting green innovation and growth, especially in transitional countries like China where financial repression is endemic. The significance of the growth of the stock market and the swings in investor mood must be acknowledged by the government.

Second, the growth of institutional investors and analysts is necessary to drive green innovation and achieve sustainable economic development in emerging markets with low institutional investor proportions and weak analyst strength. This is because institutional

ownership and analyst coverage are important external governance mechanisms that can magnify the positive impact of investor sentiment on green innovation within enterprises.

Third, previous studies indicate that non-SOEs are less naturally motivated to innovate in the green space than SOEs. This research also indicates that non-state ownership attenuates the positive influence of investor sentiment on green innovation. Governments in rising market nations and transitional economies, such as China, need to support businesses with different ownership structures in their active engagement in social responsibility and in incorporating green development into every aspect of their operations.

6.4. Limitation and Further Research

This article has several limitations:

First, our sample comes from China, a developing country. The inferences made from this might not hold true for developed nations, as companies in China and similar emerging economies, face different financial environments and positions in the global value chain, compared to those in developed countries; thus, the logic and determining factors of enterprise investment decisions, innovation awareness, and green development concepts may also differ. Furthermore, China is the biggest developing market in the world. As such, its distinct system, culture, and degree of economic growth may set it apart from other countries, which might restrict the relevance of our findings in other nations. Samples from other countries may be included in future studies, which might provide different conclusions.

Secondly, prior studies have shown that non-listed firms' investments are influenced by investor sentiment [96]. It is still unknown whether investor sentiment affects green innovation in these organisations in a comparable way. Future research is what we want to fill in these gaps.

Finally, this work overlooked the heterogeneity of institutional investors. Since the proportion of institutional investors who are resistant to pressure is much higher than that of their counterparts who are vulnerable to pressure, we did not make a distinction between them in our empirical study [69]. Future research could distinguish between them.

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References

1. Amore, M.D.; Bennedsen, M.; Larsen, B.; Rosenbaum, P. CEO education and corporate environmental footprint. *J. Environ. Econ. Manag.* **2019**, *94*, 254–273. [CrossRef]
2. Abid, N.; Ceci, F.; Ahmad, F.; Aftab, J. Financial development and green innovation, the ultimate solutions to an environmentally sustainable society: Evidence from leading economies. *J. Clean. Prod.* **2022**, *369*, 133223. [CrossRef]
3. Aftab, J.; Abid, N.; Sarwar, H.; Veneziani, M. Environmental ethics, green innovation, and sustainable performance: Exploring the role of environmental leadership and environmental strategy. *J. Clean. Prod.* **2022**, *378*, 134639. [CrossRef]
4. Sierzchula, W.; Nemet, G. Using patents and prototypes for preliminary evaluation of technology-forcing policies: Lessons from California's Zero Emission Vehicle regulations. *Technol. Forecast. Soc. Chang.* **2015**, *100*, 213–224. [CrossRef]
5. Dangelico, R.M.; Pujari, D.; Pontrandolfo, P. Green product innovation in manufacturing firms: A sustainability-oriented dynamic capability perspective. *Bus. Strategy Environ.* **2017**, *26*, 490–506. [CrossRef]

6. Mrkajic, B.; Murtinu, S.; Scalera, V.G. Is green the new gold? Venture capital and green entrepreneurship. *Small Bus. Econ.* **2019**, *52*, 929–950. [CrossRef]
7. Etzkowitz, H.; Leydesdorff, L. The endless transition: A "triple helix" of university-industry-government relations: Introduction. *Minerva* **1998**, *36*, 203–208. [CrossRef]
8. Stein, J. Rational Capital Budgeting in an Irrational World. *J. Bus.* **1996**, *69*, 429–455. [CrossRef]
9. Baker, M.; Wurgler, J. Market Timing and Capital Structure. *J. Financ.* **2002**, *57*, 1–32. [CrossRef]
10. Polk, C.; Sapienza, P. The Stock Market and Corporate Investment: A Test of Catering Theory. *Rev. Financ. Stud.* **2009**, *22*, 187–217. [CrossRef]
11. Dang, T.V.; Xu, Z. Market sentiment and innovation activities. *J. Financ. Quant. Anal.* **2018**, *53*, 1135–1161. [CrossRef]
12. Shen, H.; Zheng, S.; Xiong, H.; Tang, W.; Silverman, H. Stock market mispricing and firm innovation based on path analysis. *Econ. Model.* **2021**, *95*, 330–343. [CrossRef]
13. Rennings, K. Redefining innovation—Eco-innovation research and the contribution from ecological economics. *Ecol. Econ.* **2000**, *32*, 319–332. [CrossRef]
14. Baker, M.; Stein, J.C.; Wurgler, J. When does the Market Matter? Stock Prices and the Investment of Equity-Dependent Firms. *Q. J. Econ.* **2003**, *118*, 969–1005. [CrossRef]
15. Hua, G.; Zhou, S.; Zhang, S.; Wang, J. Industry policy, investor sentiment, and cross-industry capital flow: Evidence from Chinese listed companies' cross-industry M&As. *Res. Int. Bus. Financ.* **2020**, *53*, 101221.
16. Naughton, J.P.; Wang, C.; Yeung, I. Investor sentiment for corporate social performance. *Account. Rev.* **2019**, *94*, 401–420. [CrossRef]
17. Dyck, A.; Lins, K.V.; Roth, L.; Wagner, H.F. Do institutional investors drive corporate social responsibility? International evidence. *J. Financ. Econ.* **2019**, *131*, 693–714. [CrossRef]
18. Bekkum, S.V.; Han, S.; Pennings, E. Buy Smart, Time Smart: Are Takeovers Driven by Growth Opportunities or Mispricing? *Financ. Manag.* **2011**, *40*, 911–940. [CrossRef]
19. D'Angelo, V.; Cappa, F.; Peruffo, E. Green manufacturing for sustainable development: The positive effects of green activities, green investments, and non-green products on economic performance. *Bus. Strategy Environ.* **2023**, *32*, 1900–1913. [CrossRef]
20. Tang, M.; Walsh, G.; Lerner, D.; Fitza, M.A.; Li, Q. Green innovation, managerial concern and firm performance: An empirical study. *Bus. Strategy Environ.* **2018**, *27*, 39–51. [CrossRef]
21. Qiu, L.; Jie, X.; Wang, Y.; Zhao, M. Green product innovation, green dynamic capability, and competitive advantage: Evidence from Chinese manufacturing enterprises. *Corp. Soc. Responsib. Environ. Manag.* **2020**, *27*, 146–165. [CrossRef]
22. Sarwar, H.; Aftab, J.; Ishaq, M.I. Achieving business competitiveness through corporate social responsibility and dynamic capabilities: An empirical evidence from emerging economy. *J. Clean. Prod.* **2023**, *386*, 135820. [CrossRef]
23. Lee, K.H.; Min, B. Green R&D for eco-innovation and its impact on carbon emissions and firm performance. *J. Clean. Prod.* **2015**, *108*, 534–542.
24. Dangelico, R.M. Green product innovation: Where we are and where we are going. *Bus. Strategy Environ.* **2016**, *25*, 560–576. [CrossRef]
25. Wang, M.; Li, Y.; Li, M. Will carbon tax affect the strategy and performance of low-carbon technology sharing between enterprises? *J. Clean. Prod.* **2019**, *210*, 724–737. [CrossRef]
26. Wang, C.; Nie, P.; Peng, D.; Li, Z.H. Green insurance subsidy for promoting clean production innovation. *J. Clean. Prod.* **2017**, *148*, 111–117. [CrossRef]
27. Qi, G.; Jia, Y.; Zou, H. Is institutional pressure the mother of green innovation? Examining the moderating effect of absorptive capacity. *J. Clean. Prod.* **2021**, *278*, 123957. [CrossRef]
28. Qi, G.; Zou, H.; Xie, X. Governmental inspection and green innovation: Examining the role of environmental capability and institutional development. *Corp. Soc. Responsib. Environ. Manag.* **2020**, *27*, 1774–1785. [CrossRef]
29. Liu, Y.; Wang, A.; Wu, Y. Environmental regulation and green innovation: Evidence from China's new environmental protection law. *J. Clean. Prod.* **2021**, *297*, 126698. [CrossRef]
30. Liao, Z.; Weng, C.; Shen, C. Can public surveillance promote corporate environmental innovation? The mediating role of environmental law enforcement. *Sustain. Dev.* **2020**, *28*, 1519–1527. [CrossRef]
31. Zhang, F.; Zhu, L. Enhancing corporate sustainable development: Stakeholder pressures, organizational learning, and green innovation. *Bus. Strategy Environ.* **2019**, *28*, 1012–1026. [CrossRef]
32. Wang, H.; Khan, M.A.S.; Anwar, F.; Shahzad, F.; Adu, D.; Murad, M. Green innovation practices and its impacts on environmental and organizational performance. *Front. Psychol.* **2021**, *11*, 553625. [CrossRef] [PubMed]
33. Song, M.; Yang, M.X.; Zeng, K.J.; Feng, W. Green knowledge sharing, stakeholder pressure, absorptive capacity, and green innovation: Evidence from Chinese manufacturing firms. *Bus. Strategy Environ.* **2020**, *29*, 1517–1531. [CrossRef]
34. Zhang, C.; Jin, S. How Does an Environmental Information Disclosure of a Buyer's Enterprise Affect Green Technological Innovations of Sellers' Enterprise? *Int. J. Environ. Res. Public Health* **2022**, *19*, 14715. [CrossRef]
35. Hu, G.; Wang, X.; Wang, Y. Can the green credit policy stimulate green innovation in heavily polluting enterprises? Evidence from a quasi-natural experiment in China. *Energy Econ.* **2021**, *98*, 105134. [CrossRef]
36. Han, S.; Zhang, Z.; Yang, S. Green Finance and Corporate Green Innovation: Based on China's Green Finance Reform and Innovation Pilot Policy. *J. Environ. Public Health* **2022**, *2022*, 1833377. [CrossRef] [PubMed]

37. Zeng, Q.; Tong, Y.; Yang, Y. Can green finance promote green technology innovation in enterprises: Empirical evidence from China. *Environ. Sci. Pollut. Res.* **2023**, *30*, 87628–87644. [CrossRef]
38. Albort-Morant, G.; Leal-Millán, A.; Cepeda-Carrion, G.; Henseler, J. Developing green innovation performance by fostering of organizational knowledge and coopetitive relations. *Rev. Manag. Sci.* **2018**, *12*, 499–517. [CrossRef]
39. Arfi, W.B.; Hikkerova, L.; Sahut, J.M. External knowledge sources, green innovation and performance. *Technol. Forecast. Soc. Change* **2018**, *129*, 210–220. [CrossRef]
40. Pan, X.; Chen, X.; Sinha, P.; Dong, N. Are firms with state ownership greener? An institutional complexity view. *Bus. Strategy Environ.* **2020**, *29*, 197–211. [CrossRef]
41. Iguchi, H.; Katayama, H.; Yamanoi, J. CEOs' religiosity and corporate green initiatives. *Small Bus. Econ.* **2022**, *58*, 497–522. [CrossRef]
42. Ren, S.; Wang, Y.; Hu, Y.; Yan, J. CEO hometown identity and firm green innovation. *Bus. Strategy Environ.* **2021**, *30*, 756–774. [CrossRef]
43. Horbach, J.; Jacob, J. The relevance of personal characteristics and gender diversity for (eco-) innovation activities at the firm-level: Results from a linked employer–employee database in Germany. *Bus. Strategy Environ.* **2018**, *27*, 924–934. [CrossRef]
44. Soewarno, N.; Tjahjadi, B.; Fithrianti, F. Green innovation strategy and green innovation: The roles of green organizational identity and environmental organizational legitimacy. *Manag. Decis.* **2019**, *57*, 3061–3078. [CrossRef]
45. Wang, C.H. How organizational green culture influences green performance and competitive advantage: The mediating role of green innovation. *J. Manuf. Technol. Manag.* **2019**, *30*, 666–683. [CrossRef]
46. Sharma, S.; Prakash, G.; Kumar, A.; Mussada, E.K.; Antony, J.; Luthra, S. Analysing the relationship of adaption of green culture, innovation, green performance for achieving sustainability: Mediating role of employee commitment. *J. Clean. Prod.* **2021**, *303*, 127039. [CrossRef]
47. Amore, M.D.; Bennedsen, M. Corporate governance and green innovation. *J. Environ. Econ. Manag.* **2016**, *75*, 54–72. [CrossRef]
48. Usman, M.; Javed, M.; Yin, J. Board internationalization and green innovation. *Econ. Lett.* **2020**, *197*, 109625. [CrossRef] [PubMed]
49. Yu, C.H.; Wu, X.; Zhang, D.; Chen, S.; Zhao, J. Demand for green finance: Resolving financing constraints on green innovation in China. *Energy Policy* **2021**, *153*, 112255. [CrossRef]
50. Xiang, X.; Liu, C.; Yang, M. Who is financing corporate green innovation? *Int. Rev. Econ. Financ.* **2022**, *78*, 321–337. [CrossRef]
51. Li, X.; Shao, X.; Chang, T.; Albu, L.L. Does digital finance promote the green innovation of China's listed companies? *Energy Econ.* **2022**, *114*, 106254. [CrossRef]
52. Lin, B.; Ma, R. How does digital finance influence green technology innovation in China? Evidence from the financing constraints perspective. *J. Environ. Manag.* **2022**, *320*, 115833. [CrossRef] [PubMed]
53. Sha, Y.; Zhang, P.; Wang, Y.; Xu, Y. Capital market opening and green innovation—Evidence from Shanghai-Hong Kong stock connect and the Shenzhen-Hong Kong stock connect. *Energy Econ.* **2022**, *111*, 106048. [CrossRef]
54. Zhang, Y.; Zhang, J.; Cheng, Z. Stock market liberalization and corporate green innovation: Evidence from China. *Int. J. Environ. Res. Public Health* **2021**, *18*, 3412. [CrossRef] [PubMed]
55. Takalo, S.K.; Tooranloo, H.S. Green innovation: A systematic literature review. *J. Clean. Prod.* **2021**, *279*, 122474. [CrossRef]
56. Noailly, J.; Smeets, R. Directing technical change from fossil-fuel to renewable energy innovation: An application using firm-level patent data. *J. Environ. Econ. Manag.* **2015**, *72*, 15–37. [CrossRef]
57. Li, D.; Zhao, Y.; Zhang, L.; Chen, X.; Cao, C. Impact of quality management on green innovation. *J. Clean. Prod.* **2018**, *170*, 462–470. [CrossRef]
58. Elliott, W.B.; Koëter-Kant, J.; Warr, R.S. Market Timing and the Debt–equity Choice. *J. Financ. Intermediation* **2008**, *17*, 175–197. [CrossRef]
59. Chen, Y.S. The driver of green innovation and green image–green core competence. *J. Bus. Ethics* **2008**, *81*, 531–543. [CrossRef]
60. Hillestad, T.; Xie, C. Haugland S A. Innovative corporate social responsibility: The founder's role in creating a trustworthy corporate brand through "green innovation". *J. Prod. Brand Manag.* **2010**, *19*, 440–451. [CrossRef]
61. Chiou, T.Y.; Chan, H.K.; Lettice, F.; Chung, S.H. The influence of greening the suppliers and green innovation on environmental performance and competitive advantage in Taiwan. *Transp. Res. Part E Logist. Transp. Rev.* **2011**, *47*, 822–836. [CrossRef]
62. Huang, J.W.; Li, Y.H. Green innovation and performance: The view of organizational capability and social reciprocity. *J. Bus. Ethics* **2017**, *145*, 309–324. [CrossRef]
63. Przychodzen, J.; Przychodzen, W. Relationships between eco-innovation and financial performance–evidence from publicly traded companies in Poland and Hungary. *J. Clean. Prod.* **2015**, *90*, 253–263. [CrossRef]
64. García-Sánchez, I.M.; Gallego-Álvarez, I.; Zafra-Gómez, J.L. Do the ecoinnovation and ecodesign strategies generate value added in munificent environments? *Bus. Strategy Environ.* **2020**, *29*, 1021–1033. [CrossRef]
65. Sparkes, R.; Cowton, C.J. The maturing of socially responsible investment: A review of the developing link with corporate social responsibility. *J. Bus. Ethics* **2004**, *52*, 45–57. [CrossRef]
66. Rezende, L.A.; Bansi, A.C.; Alves, M.F.R.; Galina, S.V.R. Take your time: Examining when green innovation affects financial performance in multinationals. *J. Clean. Prod.* **2019**, *233*, 993–1003. [CrossRef]
67. Luo, X.; Wang, H.; Raithel, S.; Zheng, Q. Corporate social performance, analyst stock recommendations, and firm future returns. *Strateg. Manag. J.* **2015**, *36*, 123–136. [CrossRef]
68. Aghion, P.; Van Reenen, J.; Zingales, L. Innovation and institutional ownership. *Am. Econ. Rev.* **2013**, *103*, 277–304. [CrossRef]

69. Yang, Z.; Su, D.; Xu, S.; Han, X. Institutional investors and corporate green innovation: Evidence from China. *Pac. Econ. Rev.* **2023**, 1–37. [CrossRef]
70. Fiorillo, P.; Meles, A.; Mustilli, M.; Salerno, D. How does the financial market influence firms' Green innovation? The role of equity analysts. *J. Int. Financ. Manag. Account.* **2022**, *33*, 428–458. [CrossRef]
71. Ivković, Z.; Jegadeesh, N. The timing and value of forecast and recommendation revisions. *J. Financ. Econ.* **2004**, *73*, 433–463. [CrossRef]
72. Lui, D.; Markov, S.; Tamayo, A. What makes a stock risky? Evidence from sell-side analysts' risk ratings. *J. Account. Res.* **2007**, *45*, 629–665. [CrossRef]
73. Asquith, P.; Mikhail, M.B.; Au, A.S. Information content of equity analyst reports. *J. Financ. Econ.* **2005**, *75*, 245–282. [CrossRef]
74. Mola, S.; Rau, P.R.; Khorana, A. Is there life after the complete loss of analyst coverage? *Account. Rev.* **2013**, *88*, 667–705. [CrossRef]
75. Berrone, P.; Fosfuri, A.; Gelabert, L.; Gomez-Mejia, L.R. Necessity as the mother of 'green'inventions: Institutional pressures and environmental innovations. *Strateg. Manag. J.* **2013**, *34*, 891–909. [CrossRef]
76. Li, J.; Xia, J.; Shapiro, D.; Lin, Z. Institutional compatibility and the internationalization of Chinese SOEs: The moderating role of home subnational institutions. *J. World Bus.* **2018**, *53*, 641–652. [CrossRef]
77. Xia, J.; Ma, X.; Lu, J.W.; Yiu, D.W. Outward foreign direct investment by emerging market firms: A resource dependence logic. *Strateg. Manag. J.* **2014**, *35*, 1343–1363. [CrossRef]
78. Meyer, K.E.; Peng, M.W. Theoretical foundations of emerging economy business research. *J. Int. Bus. Stud.* **2016**, *47*, 3–22. [CrossRef]
79. Lin, J.Y.; Cai, F.; Li, Z. Competition, policy burdens, and state-owned enterprise reform. *Am. Econ. Rev.* **1998**, *88*, 422–427.
80. Song, Z.; Storesletten, K.; Zilibotti, F. Growing Like China. *Am. Econ. Rev.* **2011**, *101*, 196–233. [CrossRef]
81. Zhou, K.Z.; Gao, G.Y.; Zhao, H. State ownership and firm innovation in China: An integrated view of institutional and efficiency logics. *Adm. Sci. Q.* **2017**, *62*, 375–404. [CrossRef]
82. Chen, V.Z.; Li, J.; Shapiro, D.M.; Zhang, X. Ownership structure and innovation: An emerging market perspective. *Asia Pac. J. Manag.* **2014**, *31*, 1–24. [CrossRef]
83. Luo, X.R.; Wang, D.; Zhang, J. Whose call to answer: Institutional complexity and firms' CSR reporting. *Acad. Manag. J.* **2017**, *60*, 321–344. [CrossRef]
84. Fang, V.W.; Tian, X.; Tice, S. Does stock liquidity enhance or impede firm innovation? *J. Financ.* **2014**, *69*, 2085–2125. [CrossRef]
85. Rhodes-Kropf, M.; Robinson, D.T.; Viswanathan, S. Valuation waves and merger activity: The empirical evidence. *J. Financ. Econ.* **2005**, *77*, 561–603. [CrossRef]
86. Hadlock, C.J.; Pierce, J.R. New evidence on measuring financial constraints: Moving beyond the KZ index. *Rev. Financ. Stud.* **2010**, *23*, 1909–1940. [CrossRef]
87. To, T.Y.; Navone, M.; Wu, E. Analyst coverage and the quality of corporate investment decisions. *J. Corp. Financ.* **2018**, *51*, 164–181. [CrossRef]
88. Liu, X. Managerial myopia and firm green innovation: Based on text analysis and machine learning. *Front. Psychol.* **2022**, *13*, 911335. [CrossRef] [PubMed]
89. Li, H.; Qian, Z.; Wang, S.; Wang, J.; Wang, Q. Do green concerns promote corporate green innovation? Evidence from Chinese stock exchange interactive platforms. *Manag. Decis. Econ.* **2023**, *44*, 1786–1801. [CrossRef]
90. Zhao, J.; Qu, J.; Wei, J.; Yin, H.; Xi, X. The effects of institutional investors on firms' green innovation. *J. Prod. Innov. Manag.* **2023**, *40*, 195–230. [CrossRef]
91. Saunders, E.M. Stock prices and Wall Street weather. *Am. Econ. Rev.* **1993**, *83*, 1337–1345.
92. Hirshleifer, D.; Shumway, T. Good day sunshine: Stock returns and the weather. *J. Financ.* **2003**, *58*, 1009–1032. [CrossRef]
93. Baker, M.; Wurgler, J. Investor Sentiment and the Cross-Section of Stock Returns. *J. Financ.* **2006**, *61*, 1645–1680. [CrossRef]
94. Campello, M.; Graham, J.R. Do stock prices influence corporate decisions? Evidence from the technology bubble. *J. Financ. Econ.* **2013**, *107*, 89–110. [CrossRef]
95. Fu, J.; Wu, X.; Liu, Y.; Chen, R. Firm-specific investor sentiment and stock price crash risk. *Financ. Res. Lett.* **2021**, *38*, 101442. [CrossRef]
96. Badertscher, B.A.; Shanthikumar, D.M.; Teoh, S.H. Private Firm Investment and Public Peer Misvaluation. *Account. Rev.* **2019**, *94*, 31–60. [CrossRef]