ISSN 2616-5902 Vol. 6, Issue 7: 96-102, DOI: 10.25236/AJBM.2024.060713

Research on the Impact of Small and Medium Sized Investor Relationship Management in Capital Markets on Green Innovation of Enterprises

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Abstract: *Based on stakeholder theory, information asymmetry theory, and principal-agent theory, this article takes non-financial industry listed companies in China's Shanghai and Shenzhen A-shares from 2010 to 2021 as the research object. Relying on the online investor relationship management platforms of "Interactive Easy" on the Shenzhen Stock Exchange and "e-Interactive" on the Shanghai Stock Exchange, this article constructs overall investor relationship management indicators from three aspects: completion, effectiveness, and timeliness to discuss the relationship between investor relationship management and corporate green innovation. This article first explores the impact of investor relationship management on corporate green innovation, and analyzes the moderating effect of corporate visibility. Based on this, it delves into the specific manifestations, mechanisms, and economic consequences of investor relationship management's impact on corporate green innovation. The empirical results indicate that in terms of the impact effect of investor relationship management on corporate green innovation, investor relationship management can significantly promote corporate green innovation, and this impact effect is greater in companies with lower visibility.*

Keywords: *small and medium-sized investors; Investor relationship management; Green innovation of enterprises; Exchange interactive platform*

1. Introduction

Green technology innovation is a key factor in coordinating economic growth and environmental protection (Magat, 1978) [1], and it is also an inevitable choice for enterprises to enhance their competitiveness (Chang, 2011; Apak and Atay, 2015) [2,3]. The report of the 19th National Congress of the Communist Party of China proposes to "accelerate the reform of the ecological civilization system and build a beautiful China", and clearly requires the construction of a market-oriented green technology innovation system. In order to implement the requirements of the 19th National Congress, the National Development and Reform Commission and the Ministry of Science and Technology issued the "Guiding Opinions on Building a market-oriented green technology innovation system" in April 2019, strengthening the role of the market in the green innovation system. At present, there is a wealth of research on green innovation in enterprises both domestically and internationally, and a basic consensus has been reached. Green innovation in enterprises is driven by a series of factors, including environmental regulations (Porter and Van der Linde, 1995) [4], stakeholder pressure (Darnall et al., 2010; Xiao Xiaohong et al., 2021) [5,6], enterprise resources and capabilities (Khanna et al., 2009) [7], enterprise organizational characteristics (Chen, 2008; S á nchez and Deza, 2012) [8], and market orientation (Xiao Hailin and Chen Yanan, 2022). , etc. Although scholars at home and abroad have found the important role of market orientation in studying the influencing factors of green innovation in enterprises, the perspectives chosen by these studies are mostly based on the needs of consumer centered product markets. Especially based on evolutionary game models, scholars have derived the promoting or inhibiting effects of product market demand on green innovation in enterprises (Wang Mingyue and Li Yingming, 2021; Xiao Hailin and Chen Yanan, 2022) . Unfortunately, few scholars have paid attention to the capital market driving forces of corporate green innovation, and there is a lack of testing the impact of external factors on corporate green innovation. Therefore, how to stimulate the capital market to improve or maintain the green innovation capability of enterprises has become one of the hot topics in the research of green innovation driven development of enterprises under market orientation.

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2. Sample Selection and Data Sources

This article selects Chinese A-share listed companies in Shanghai and Shenzhen from 2010 to 2021 as research samples to study the relationship between investor relationship management and corporate green innovation based on exchange interactive platforms. Referring to the practices of existing research, this article processes the data as follows: ① Remove all company samples from the financial industry; ② Exclude all ST and * ST listed companies; ③ Delete samples with missing primary variables. Finally, 24918 samples were obtained. The investor relationship management data used in this article is derived from the interactive data on the "Interactive Easy" platform of the Shenzhen Stock Exchange and the "e-Interactive" platform of the Shanghai Stock Exchange in the China Research Data Service Platform (CNRDS). The enterprise green innovation data is based on the patent classification number information of A-share listed companies in the China Research Data Service Platform (CNRDS), matched with the "International Patent Classification Green List" published by the World Intellectual Property Organization (WIPO) in 2010, to identify and account for enterprise green patents. The characteristic data of other companies mainly comes from Wind database and CSMAR database. In order to avoid the influence of extreme values on the test results, this article applies Winsorization to the 1% and 99% quantiles of the main continuous variables.

3. Research model

In order to examine the impact of investor relationship management on green innovation in enterprises, this article constructs the following model:

$$\text{Green\_INNO}_{i,t} = \beta_0 + \beta_1 \text{IRM}_{i,t} + \beta_2 \sum \text{Controls}_{i,t} + \sum \text{Year} + \sum \text{Industry} + \varepsilon_{i,t} \quad (1)$$

Among them, Green-INNO represents green innovation of the enterprise; IRM stands for investor relationship management, which is measured by three sub indicators: the completion, effectiveness, and timeliness of interaction and communication between enterprises and investors on the exchange's interactive platform; Controls represent a series of control variables that may affect a company's green innovation activities. According to Hypothesis 1, the coefficient of investor relationship management is expected to promote green innovation in enterprises β_1Significantly positive.

4. Descriptive statistics

After processing, a total of 24918 samples were obtained in this article, and Table 1 presents the descriptive statistical results of the research variables. According to Table 1, the mean and median values of Green Innovation in Enterprises (Green-INNO) are 1.034 and 0.693, respectively. There is a gap between the mean and median values, with a standard deviation of 1.212, a minimum value of 0, and a maximum value of 4.844, indicating significant differences in the level of green innovation among different sample companies. Based on the descriptive statistics of the number of green innovation patent applications and authorizations by industry in Table 2,,it can be found that the manufacturing industry, construction industry, mining industry, information transmission industry, software and information technology services industry, power, heat, gas and water production and supply industry, as well as water, environment, and announcement facility management industry, have the highest number of applications and authorizations for green innovation patents in the industry.

Completion, Validity, and Timeliness are measures of investor relationship management. The average completion index is 0.899, indicating that listed companies have a high frequency of interaction with investors on the exchange interaction platform; The mean value of the effectiveness indicator is 0.636, indicating that the average response of listed companies to investor questions containing valid information content is 63.6%; Considering the measurement method of timeliness indicators, there is a situation where listed companies have not responded to investor questions in a certain year. In order to ensure the reliability of the indicators, this missing situation was not removed. Therefore, the observed value of timeliness indicators is 24126, with a mean of 0.769, a median of 0.789, and a standard deviation of 0.139, indicating that listed companies respond to questions on the exchange interactive platform in a timely manner.

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Table 1: Descriptive Statistical Analysis

variable	Observations	mean value	Maximum value	minimum value	median	standard deviation
Green_INNO	twenty-four thousand nine hundred and eighteen	one point zero three four	four point eight four four	0	zero point six nine three	one point two one two
Completion	twenty-four thousand nine hundred and eighteen	zero point eight nine nine	one	0	one	zero point two three zero
Validity	twenty-four thousand nine hundred and eighteen	zero point six three six	one	0	zero point six eight zero	zero point two six three
Timeliness	twenty-four thousand one hundred and twenty-six	zero point seven six nine	one	0	zero point seven eight nine	zero point one three nine
Labor	twenty-four thousand nine hundred and eighteen	seven point six six nine	eleven point two two zero	four point four five four	seven point five eight three	one point two five seven
Lev	twenty-four thousand nine hundred and eighteen	zero point four one six	zero point nine two seven	zero point zero five zero	zero point four zero six	zero point two zero nine
Roa	twenty-four thousand nine hundred and eighteen	zero point zero three nine	zero point one nine five	-0.257	zero point zero three nine	zero point zero six one
MB	twenty-four thousand nine hundred and eighteen	four point zero one two	twenty-five point two zero zero	one point two two three	three point one two three	three point two eight zero
Cash	twenty-four thousand nine hundred and eighteen	zero point two zero five	twenty-five point two four zero	zero point zero zero two	zero point one six one	zero point two two seven
RD	twenty-four thousand nine hundred and eighteen	zero point zero zero five	zero point one one zero	0	0	zero point zero one seven
RDmissing	twenty-four thousand nine hundred and eighteen	zero point four five nine	one	0	0	zero point four nine eight
Capital	twenty-four thousand nine hundred and eighteen	zero point zero five one	zero point two three three	0	zero point zero three six	zero point zero four seven zero
Ppe	twenty-four thousand nine hundred and eighteen	zero point two zero eight	zero point six nine eight	zero point zero zero two	zero point one seven five	zero point one five eight
Dual	twenty-four thousand nine hundred and eighteen	zero point two nine five	one	0	0	zero point four five six
Ind	twenty-four thousand nine hundred and eighteen	thirty-seven point five four zero	fifty-seven point one four zero	thirty-three point three three three	thirty-five point seven one zero	five point three two five
Age	twenty-four thousand nine hundred and eighteen	two point seven nine five	three point four six six	one point three eight six	two point eight three three	zero point three eight four
TQ	twenty-four thousand nine hundred and eighteen	zero point five nine three	two point two one seven	-0.141	zero point four nine one	zero point four eight seven
Size	twenty-four thousand nine hundred and eighteen	twenty-two point one seven zero	twenty-six point two five zero	nineteen point seven one zero	twenty-one point nine eight zero	one point three two zero

Table 2: Descriptive statistics of the number of green innovation patent applications and authorizations by industry from 2010 to 2021

Industry name	Industry classific-ation	Green innovation patent application		Green innovation patent authorization	
		Quantity (pieces)	Proportion (%)	Quantity (pieces)	Proportion (%)
Agriculture, forestry, animal husbandry, and fishing	A	five hundred and ninety-two	zero point two six eight nine	three hundred and thirty-eight	zero point two three nine seven
Mining	B	fifteen thousand one hundred and one	six point eight six one four	eleven thousand seven hundred and eighty-six	eight point three five nine two
manufacturing	C	one hundred and	sixty-five point	ninety-one	sixty-five

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		forty-three thousand four hundred and thirty-two	one seven one four	thousand eight hundred and fifty-nine	point one five zero nine
Electricity, heat, gas and water production and supply	D	ten thousand four hundred and seventy-five	four point seven five nine five	seven thousand four hundred and forty-one	five point two seven seven five
construction	E	twenty-three thousand eight hundred and twenty-one	ten point eight two three five	fifteen thousand four hundred and sixty-three	ten point nine six seven one
Wholesale and retail	F	one thousand six hundred and fifty-six	zero point seven five two four	eight hundred and ninety-six	zero point six three five four
Transportation, storage and postal services	G	two thousand two hundred and fifty-six	one point zero two five zero	nine hundred and sixty	zero point six eight zero eight
Accommodation and catering	H	five	zero point zero zero two two	two	zero point zero zero one four
Information transmission, software and information technology services	I	twelve thousand four hundred and thirty-nine	five point six five one nine	five thousand two hundred and seventy-two	three point seven three nine one
real estate	K	one thousand one hundred and sixty	zero point five two seven zero	five hundred and twenty-six	zero point three seven three zero
Leasing and Business Services Industry	L	four hundred and ten	zero point one eight six two	one hundred and eighty-two	zero point one two nine zero
Scientific research and technology services	M	one thousand nine hundred and ten	zero point eight six seven eight	one thousand three hundred and fifteen	zero point nine three two six
Water conservancy, environment and public facilities management	N	five thousand six hundred and eighty-four	two point five eight two six	four thousand two hundred and ninety-eight	three point zero four one nine
Residential services, repair and other services	O	forty	zero point zero one eight one	eighteen	zero point zero one two seven
education	P	five	zero point zero zero two two	four	zero point zero zero two eight
Health and social work	Q	sixty-five	zero point zero two nine five	forty-eight	zero point zero three four zero
Culture, sports and entertainment	R	two hundred and thirty-two	zero point one zero five four	fifty-nine	zero point zero four one eight
comprehensive	S	eight hundred and one	zero point zero zero three six	five hundred and twenty-seven	zero point three seven three seven
total		two hundred and twenty thousand and eighty-four	one hundred	one hundred and forty thousand nine hundred and ninety-four	one hundred

5. Correlation analysis

To verify the correlation between the main variables in this article and whether there is multicollinearity, Pearson correlation analysis was conducted on all variables, and the results are shown in Table 3. The validity and timeliness indicators representing investor relationship management, as well as green innovation (Green-INNO), are both significant at the 1% statistical level, but completion has not shown a significant correlation yet. Further verification through multiple regression is needed in the following text. At the same time, there is a significant correlation between the control variables selected in this article and the dependent variable, and the selection of control variables is more appropriate. In addition, the correlation coefficients between the variables in this article are all over 0.5, indicating that there is no severe multicollinearity in the model.

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Table 3: Pearson correlation coefficient table

Variable Name	Green_INNO	Completion	Validity	Timeliness	Labor	Lev	Roa	MB	Cash	RD	RDmissing	Capital	Ppe	Ind	Age	TQ	Size
Green_INNO	1																
Completion	-0.01	1															
Validity	0.04	0.64	1														
Timeliness	0.03	0.22	0.07	1													
Labor	0.40	-0.06	-0.03	-0.04	1												
Lev	0.21	-0.11	-0.06	-0.08	0.37	1											
Roa	-0.01	0.06	0.05	0.02	0.03	-0.39	1										
MB	-0.05	-0.07	-0.11	-0.02	-0.09	0.38	-0.16	1									
Cash	-0.07	0.03	0.04	0.01	-0.17	-0.28	0.15	-0.02	1								
RD	0.05	0.02	0.01	0.06	-0.03	-0.09	-0.04	0.02	0.03	1							
RDmissing	0.09	0.01	0.05	-0.01	0	0.01	0.01	-0.06	-0.04	-0.26	1						
Capital	-0.01	0.06	0.06	0.03	0.07	-0.09	0.13	-0.08	-0.05	0.03	-0.08	1					
Ppe	-0.03	-0.03	-0.04	-0.05	0.23	0.11	-0.08	-0.05	-0.24	-0.10	0	0.28	1				
Ind	0.02	-0.01	0	0.02	-0.02	0	-0.02	0.03	0.01	0.02	0.03	0	-0.05	1			
Age	0.09	-0.05	-0.03	-0.02	0.12	0.23	-0.11	0.11	-0.14	-0.05	0.26	-0.19	0.05	0	1		
TQ	-0.18	0.01	-0.07	0.05	-0.34	-0.30	0.15	0.55	0.14	0.11	-0.09	0	-0.12	0.04	-0.05	1	
Size	0.44	-0.11	-0.03	-0.06	0.75	0.52	-0.03	-0.08	-0.21	-0.03	0.08	-0.06	0.13	0.01	0.24	-0.48	1

6. The impact of investor relationship management on green innovation in enterprises

Table 4: Investor Relationship Management and Enterprise Green Innovation

Variable Name	Green_INNO					
	(1)	(2)	(3)	(4)	(5)	(6)
Completion	0.1815	0.1271				
	(3.4086)	(2.7258)				
Validity			0.1947	0.1082		
			(4.3242)	(2.6308)		
Timeliness					0.3813	0.1734
					(6.1567)	(2.9837)
Labor	0.1796	0.0860	0.1814	0.0869	0.1769	0.0882
	(9.3137)	(5.1407)	(9.4352)	(5.2033)	(8.9684)	(5.1629)
Lev	0.2201	0.4613	0.2152	0.4576	0.2292	0.4527
	(2.4085)	(5.3108)	(2.3613)	(5.2686)	(2.4513)	(5.0946)
Roa	-0.6495	-0.3164	-0.6568	-0.3149	-0.6345	-0.3119
	(-3.8423)	(-1.9775)	(-3.8897)	(-1.9700)	(-3.6883)	(-1.9171)
MB	-0.0231	-0.0181	-0.0227	-0.0179	-0.0242	-0.0175
	(-5.0395)	(-4.4090)	(-4.9898)	(-4.3785)	(-5.4263)	(-4.2784)
Cash	0.0235	0.0231	0.0168	0.0212	0.0300	0.0277
	(0.6860)	(0.6864)	(0.5171)	(0.6438)	(0.8329)	(0.7918)
RD	5.0014	-0.0917	4.9510	-0.0929	4.7855	-0.0645
	(5.8593)	(-0.1114)	(5.8154)	(-0.1128)	(5.5382)	(-0.0775)
RDmissing	0.2120	-0.2152	0.2077	-0.2153	0.2074	-0.2066
	(9.3602)	(-6.2615)	(9.1647)	(-6.2646)	(9.0430)	(-5.9882)
Capital	0.8620	0.4887	0.8258	0.4853	0.8430	0.4897
	(3.4777)	(2.1400)	(3.3257)	(2.1237)	(3.3636)	(2.1195)
Ppe	-0.8663	-1.0842	-0.8579	-1.0822	-0.8379	-1.0816
	(-8.5415)	(-11.2639)	(-8.4732)	(-11.2431)	(-8.1642)	(-10.9619)
Dual	0.0499	0.0124	0.0506	0.0130	0.0500	0.0158
	(1.7516)	(0.4721)	(1.7771)	(0.4964)	(1.7361)	(0.5965)
Ind	0.0020	0.0000	0.0019	-0.0001	0.0007	-0.0011
	(0.7625)	(0.0031)	(0.7246)	(-0.0236)	(0.2461)	(-0.4446)
Age	-0.0655	-0.1575	-0.0654	-0.1569	-0.0558	-0.1495
	(-1.5310)	(-3.7629)	(-1.5296)	(-3.7461)	(-1.2931)	(-3.5299)
TQ	0.2028	0.2159	0.2092	0.2159	0.1956	0.2020
	(6.0411)	(6.0114)	(6.2393)	(6.0313)	(5.8906)	(5.6094)
Size	0.3132	0.3829	0.3111	0.3811	0.3128	0.3789
	(14.1358)	(17.7658)	(14.0916)	(17.7496)	(13.9301)	(17.3077)
Constant	-7.4427	-8.4530	-7.3645	-8.3705	-7.5080	-8.3580
	(-17.6863)	(-18.8596)	(-17.7583)	(-18.9529)	(-17.9850)	(-18.5825)
Industry	no	yes	no	yes	no	yes
Year	no	yes	no	yes	no	yes
N	24918	24918	24918	24918	24126	24126
Adj. R2	0.2328	0.3547	0.2334	0.3546	0.2313	0.3510

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Note: * * *, * *, and * represent significant values at the 1%, 5%, and 10% levels, respectively. The two tailed test t-values are shown in parentheses. The standard error is adjusted by the clustering effect of the enterprise.

To verify Hypothesis 1, this study brought sample data into Model 4-2 for regression. The regression results are shown in Table 4, where columns (1), (3), and (5) did not control for annual and industry effects, while columns (2), (4), and (6) controlled for annual and industry effects. In terms of specific results, columns (1) and (2) present the impact of completion indicators on corporate green innovation, with regression coefficients of 0.1815 and 0.1271, which are significantly positive at the 1% level; Columns (3) and (4) show the impact of effectiveness indicators on corporate green innovation, with regression coefficients of 0.1974 and 0.1082, which are significantly positive at the 1% level. Columns (5) and (6) show the regression results between timeliness indicators and corporate green innovation, with regression coefficients of 0.3818 and 0.1734, respectively, which are also significantly positive at the 1% level. The presented results effectively validate hypothesis 1, that is, investor relationship management can significantly promote green innovation in enterprises.

7. Research conclusion

This article is based on three major theories and proposes the hypothesis that investor relationship management promotes green innovation in enterprises through information and governance effects, especially in enterprises with low visibility. The study focuses on non-financial listed companies in A-shares of the Shanghai and Shenzhen stock markets in China, and uses exchange interactive platform data to empirically test the impact of investor relationship management on corporate green innovation. Furthermore, the study explores its specific manifestations, mechanisms, and economic consequences.

One is that investor relationship management is positively correlated with green innovation in enterprises, and the impact is more significant in low visibility enterprises. It promotes green innovation in enterprises through information and governance effects, including ensuring investor access and interpretation of information, improving information asymmetry, and helping investors supervise listed companies and improve agency issues.

The second is that investor relationship management mainly promotes strategic green innovation, but its "green" module significantly promotes the quantity and quality of green innovation. This means that targeted "green" interactions with investors can drive listed companies to engage in high-quality green innovation.

Thirdly, investor relationship management promotes green innovation in enterprises by reducing agency costs, demonstrating its important role in corporate governance, enabling small and medium-sized investors to participate more in corporate governance and promote green innovation activities.

Fourthly, investor relationship management not only directly affects the environmental performance of enterprises, but also indirectly improves environmental performance by promoting green innovation. This indicates that valuing investor relationship management can help companies achieve better environmental performance and enhance their value.

8. Inspiration and suggestions

Strengthen protection and guidance for small and medium-sized investors:The users of online investor relations platforms are mostly individual investors who have limited professional knowledge and are easily misled by listed companies. To protect the rights and interests of small and medium-sized investors, regulatory authorities need to strengthen investor education, release the latest policy updates, and enhance the identification ability of investors. At the same time, it is necessary to broaden the channels for small and medium-sized investors to participate in corporate governance, introduce and improve relevant policies, safeguard their voice, and play their external supervision and governance role.

Improve the functional modules of the investor relationship management platform: In April 2022, the China Securities Regulatory Commission issued a new "Guidelines for Investor Relations Management of Listed Companies", which has attracted much attention to investor relations management. With the development of digitalization, online investor relationship management platforms have become the main channel due to their interactivity and real-time nature, especially the "Interactive Easy" and "SSE e-Interactive" platforms. However, the current platform information is scattered, and it is recommended

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to implement specialized modular settings, such as adding "green" modules, to reduce the cost of information collection and integration.

Standardize investor relationship management behavior of listed companies:Given the importance of investor relationship management, regulatory authorities should guide listed companies to use online investor relationship management platforms in a standardized manner. Targeted regulatory systems and specialized training can be developed to enhance the standardization of listed companies on this platform, and non-standard behaviors can be seriously dealt with and included in the focus of attention.

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