Does green investment improve company performance--Empirical Analysis Based on Reputation Perspective

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Abstract. Under the influence of the background of "carbon peak", "carbon neutrality" and "Clear waters and green mountains", the green investment of firms has become a part of the green development of companies, which has aroused widespread concern in the academic community. Based on the data of listed companies in heavy pollution industries from 2008 to 2020, this paper constructs a panel fixed effect model to examine whether green investment will improve the performance of firms. The study found that green investment has a positive role in promoting company performance. Further heterogeneous analysis shows that green investment has a more significant impact on the performance of state-owned firms. In terms of mechanism, the research results show that green investment promotes company performance mainly by improving the reputation of firms. Based on the above results, it provides some reference experience for the guidance of green investment from the perspective of reputation.

Keywords: Green investment; Green development; Company performance; Reputation

1. Introduction

In recent years, China has always attached great importance to the construction of ecological civilization and green development. China's economy has shifted from high-speed development to high-quality development, abandoning the previous practice of sacrificing the ecological environment for economic development speed. The Chinese government actively encourages and supports firms' green practices in energy conservation and emission reduction, and improving environmental pollution through green investment has gradually become an important decision in the production and operation process of firms (Wang et al., 2018) [1].The Chinese government is trying to achieve the goal of achieving a carbon peak by 2030 and carbon neutrality by 2060, so green investment is particularly important for Chinese companies.

Firms are the main body of the economy and the main producers of environmental pollution. The vast majority of environmental problems in China are caused by corporate pollution discharge, so firms should bear the main responsibility for environmental governance. As an economic means of environmental protection, green investment can promote firms to optimize their production capacity structure and improve their production technology. Firms should be encouraged to expand the scale of green investment and establish an environmental governance model led by the government and dominated by firms.

Green investment, as a new mixed practice combining financial means and environmental objectives, will have an impact on the business activities of firms in terms of revenue, cash flow, production efficiency, etc. In terms of revenue, green investment will urge firms to increase technological innovation, overcome technological bottlenecks, optimize product design and production processes, reduce product energy consumption and waste emissions, increase the output of unit resources, expand market share and generate more revenue growth. In terms of cash flow, on the one hand, the green investment of the company can make the company take the lead in assuming certain social responsibilities and disclose more environmental information, thus reducing the capital cost of the company and playing a positive role in promoting the performance of the company. On the other hand, from the perspective of regulatory costs, firms take the lead in assuming social responsibilities and making environmental disclosure and other behaviors, which can be used by the market as a means to evaluate the possibility of future regulation, thus affecting the future cash flow. In terms of production efficiency, green investment has significantly improved the total factor

productivity of firms by stimulating the innovation vitality of firms, actively promoting firms to upgrade the original production technology and reducing unnecessary costs (Liu Ye and Lin Chendan, 2021) [2].

Is green investment of firms sure to improve company performance? As green investment meets the regulatory requirements, green investment can improve the public image of firms and further enhance the reputation of firms. External investors are willing to provide financial support to promote the improvement of company performance; Internally, increasing green investment of firms will increase R&D investment of firms, and the increase of costs may inhibit the improvement of company performance. Moreover, due to the technology spillover effect of innovation activities, it exacerbates the information asymmetry between firms and investors. R&D investment projects themselves have characteristics such as long cycles, high investment, and uncertain returns. Therefore, for internal investors, the degree of information asymmetry and the high risk level of the project make them unwilling to provide financial support to firms, leading to financing constraints during company R&D activities, not conducive to the improvement of company performance.

With the proposal of the "Porter hypothesis", traditional views have been questioned. Under environmental regulation, this change can enable firms to convert their green spending into technological innovation, thereby gaining a competitive advantage and promoting the improvement of business performance, thus achieving a win-win situation. Based on this, many scholars have reexamined the issue of whether it is worthwhile for firms to contribute to green development. Antonietti and Marzucchi [4] take the manufacturing industry as an example to verify that green investment can improve the production efficiency of firms, thus improving export performance; Sueyoshi [3] and other researchers found that green investment and other expenditures in the U.S. energy industry can significantly improve the business performance measured by return on assets and environmental performance measured by carbon emissions. Various studies have verified the positive correlation between green investment and business performance, that is, green investment can improve the performance of firms.

Another view is that the relationship between green investment and company performance is not always linear or significant. In different stages of green investment, its impact on corporate performance is also different, which may present a more complex mechanism. Huang Rongbing et al.[7] found that there is no significant correlation between the "green washing" behavior of listed companies in China's heavily polluting industries in whitewashing environmental performance and their operating performance measured by return on equity; Nakamura and Eri [5] used Japanese companies as research samples and found that the short-term impact of increased environmental investment expenditure on performance was not significant, while the long-term impact was more significant; Pekovic et al. [6] used French companies as research samples and found that when the scale of environmental investment crosses the inflection point of the "inverted U-shaped" curve, further environmental investment by firms will damage their operating performance (net profit).

In this article, we answered how green investment will affect company performance. The research contributions of this paper are mainly reflected in the following aspects: First, this paper considers the flexibility of company operation and development from the perspective of green investment, explains the adaptability of company operation and development to green investment, and enriches the research on environmental and economic development. Secondly, based on the reputation mechanism, this paper discusses the positive role of green investment in promoting company performance. Thirdly, this article uses the panel fixed effects model for empirical testing, which can provide correct guidance for optimizing the internal investment structure of firms.

The rest of this paper will be carried out in the following order. The second part is the literature review and theoretical analysis of green investment to explore the impact mechanism of green investment on company performance. The third part is research design, the fourth part is empirical results analysis, and the fifth part is research conclusions and suggestions.

2. Literature Review and Theoretical Analysis

(1) The Impact of Green Investment on company Performance

In 1989, the economist Pierce first proposed "green economy" in the "Green Economy Bluebook". Adapting to the green economy, the investment in the development of green economy is called green investment (GI) [8]. Green investment is proposed in the context of sustainable development strategy. It is an internal investment that can reduce the environmental cost of firms and achieve the goal of improving environmental performance. Liu Beibei and other researchers have stated that the Chinese government has introduced stakeholders to participate in corporate environmental governance and achieved certain results. Among them, government environmental regulations have mandatory constraints on corporate behavior. Faced with the pressure of stakeholders, firms will actively take on corresponding social responsibilities to better meet their demands, improve their own environmental governance level, and thereby enhance their green competitiveness and promote the improvement of environmental performance [9]. In order to cope with the pressure from stakeholders, companies have a strong motivation to increase environmental spending and better meet the demands of stakeholders. The use of some resources by firms for environmental protection can enhance their green competitiveness. Implementing green production practices will improve environmental performance and gain recognition from stakeholders. Therefore, Saunila et al [10]believed that the more a company values sustainable economic, institutional and social development, the more willing it is to invest in green innovation. That is to say, the more companies attach importance to environmental strategy, the better environmental performance they can achieve [11] (Cheng Qiaolian and Tian Yezhuang, 2012). Chen Yufeng [12] and others confirmed that firms' increasing green investment can reduce the probability of environmental violations, thus improving environmental performance, and the moderating effect of firms' R&D investment on both is not significant. Zhao Lingdi [13] and other studies show that green ivestment affects business performance through the Mesomeric effect of productive Sexual capital investment and technological innovation. Most research results show that there is a significant positive correlation between green investment and financial performance (Hu Quying, 2012 [14]; Dixon Fowler et al., 2013 [15]; Zhang et al., 2019 [16]). With the improvement of green governance, the company can obtain higher growth capacity, lower assumption of risk level, more relaxed financing constraints and higher long-term value.

To sum up, green investment is conducive to the sustainable development of firms, is an important driving force for firms to improve their own environmental governance level, and further promotes the improvement of company performance. Therefore, propose research hypotheses

H1a: Green Investment can significantly improve company performance.

Secondly, the nature of company ownership is also an important factor affecting the relationship between green investment and company performance. Further research on the manufacturing industry has found that state-owned firms have a stronger level of technology and management compared to private firms, and their environmental protection is in place (Wang Ping, 2013) [18]. Moreover, industries with relatively concentrated pollution emissions have lower intensity (Yang Fan et al., 2016) [17]. Wang Yuan and Liu Ru (2019) [19] compared and studied the relationship between the nature of company ownership, environmental pollution and economic development in different regions, and found that in regions with more state-owned firms, firms made more green investment, and the effect of environmental regulation was good. Compared with private firms, state-owned firms have a stronger sense of social responsibility based on their state ownership nature, and are superior to private firms in pollution control (Earnhart and Lizal, 2007 [20]; Lee., 2010 [21]). From the perspective of internal management, there are significant differences in the target functions and costs of driving control among managers of different ownership systems. The decision-making and behavior of state-owned firms are to some extent influenced by government guidance, However, non-state-owned firms are more focused on pursuing market-oriented profit maximization, focusing on developing green innovative products through accumulation and research and development of green technologies, so as to improve the financial performance of firms. From the perspective of external competition among firms, state-owned firms are more likely to obtain scarce resources from the

government through close political connections, improve their innovation efficiency, and promote the improvement of company performance. Non state-owned firms face more severe market competition, and their performance improvement will be slower than state-owned firms. To sum up, there are differences in the relationship between green investment and business performance under different property rights. Compared with non-state-owned firms, state-owned firms' green investment has a greater and more significant nonlinear impact on business performance. Therefore, the hypothesis is proposed

H1b: state-owned firms' green investment has greater impact on business performance than non-state-owned firms

(2) The impact of green investment on corporate reputation

With environmental pollution becoming an increasingly serious social problem, environmental performance has become an integral part of corporate reputation and an important way for firms to manage their reputation. Good environmental performance is conducive to establishing a good reputation that focuses on the interests of stakeholders rather than solely on maximizing economic benefits, forming a good image in the minds of investors, and thus bringing positive reputation advantages to firms. Green investment is a more accurate and intuitive indicator that can reflect the environmental performance of firms [22] [23]. It can more directly show the good social image of firms that pay attention to social livelihood and environmental protection, and is directly conducive to the maintenance of corporate reputation and image [24] [25]. As an important expenditure for firms to reduce pollution emissions, Green Investment is not only a more intuitive and hard indicator to measure the environmental performance of firms, but also an environmental protection decision that firms can respond quickly, which makes it possible for firms to conduct reputation management through green investment.

Green investment can bring positive reputation effects to firms, calling on firms to focus on long-term and sustainable development, rather than just focusing on the realization of short-term economic benefits. Therefore, the hypothesis is proposed

H2: Green Investment can improve corporate reputation

Corporate reputation and performance

Reputation, as an intangible asset of a company, creates value for the company just like tangible assets. Environmental performance has become an integral part of corporate reputation and an important way for companies to manage their reputation [26]. A good reputation can enhance the impression of a company in the minds of investors, attract investment from investors, reduce the difficulty of financing, and thus bring better corporate performance. Fame and reputation, as corporate reputation capital, can effectively enhance the corporate image and attract more stakeholders. For example, consumers are more willing to spend their disposable income on the products of reputable and high-quality firms, and firms with good reputation will also attract more outstanding talents, equity or debt investors in production and operation, which can improve financial performance and increase corporate value. The research of Tang Guoping [27] and others shows that firms' green investment can bring good corporate reputation, attract external investors to invest, and further improve the performance of firms by obtaining support from external resources. Therefore, the hypothesis is proposed

H3: The improvement of corporate reputation can enhance corporate performance

3. Research Design

(1) Sample selection and data processing

This paper selects China's heavy pollution industry from 2008 to 2020 as the research object. The green investment and financial data used are from CSMAR Guotai'an Database and WIND Wande Database, and patent related data are from the patent retrieval website of the China National Intellectual Property Administration. After excluding financial samples and company samples with ST stock market performance for the year, some missing values were supplemented and further data

missing samples were removed. Finally, a 1% level tail reduction was performed on the sample data, resulting in a total of 32341 observation samples.

Variable Definition

1.Explained Variable: company performance indicators. According to the definition of the Ministry of Finance of China, corporate performance refers to the operational efficiency and operator performance of a company during a certain operating period. The level of operational efficiency of firms is mainly reflected in aspects such as profitability, asset operation level, debt repayment ability, and subsequent development ability. Financial performance plays a key role in company performance evaluation. Considering the objectivity and representativeness of corporate performance indicators, combined with relevant literature and the actual performance of listed companies in heavily polluting industries, this article draws on the research of Li Li and Lin Yuyan (2021) [28] and adopts the most widely used measurement indicator, Return on Assets (ROA), as the measurement indicator of financial performance. This indicator is used to measure how much net profit is generated per unit of assets.

2. Explanatory variable: Green Investment. From Eyraud et al (2013) [29], it can be seen from the definition of green investment that various capital expenditures related to environmental protection are included in green Investment of firms, such as financial investment in renewable technology, selection of energy-saving technology, research and development of green investment, etc., which aims to reduce greenhouse gas emissions and air pollution. Therefore, investment in energy conservation and emission reduction (i.e. Green Investment) has gradually become one of the important business decisions of firms (Wang et al., 2018) [1]. Drawing on the treatment methods of Wang Yun [30] and others, this paper manually collects and sorts out various green expenditures that meet the definition of green investment according to the corporate social responsibility report, financial report and other documents publicly disclosed by listed companies, and takes Natural logarithm to measure the Green Investment (GI) of firms.

3. Control variables: This article takes variables such as company size, financial leverage, company growth, cash flow from operating activities, proportion of accounts receivable, proportion of sole directors, and company age as control variables.

Table 3-1. The specific definitions of each variable

Variable Type	Variable name	Variable Symbolic	Variable Definition
Dependent variable	Finance performance	ROA	Net profit/average total assets
Independent variable	Green investment	GI	Total environmental protection expenditure is taken as Natural logarithm
Adjusting variable	Corporate reputation	Reputation	Number of positive and negative news reports
Control variables	Corporate size	Size	Natural logarithm of total assets at the end of the year
	Finance leverage	Lev	Total liabilities at the end of the year divided by total assets at the end of the year
	Company Growth	Growth	(Total assets at the end of the current period - total assets at the end of the previous period)/total assets at the end of the previous period
	Cash flow from operating activities	Cash flow	Cash balance/total assets
	Proportion of accounts receivable	REC	Ratio of net accounts receivable to total assets
	Proportion of independent directors	IDR	Number of independent directors/board of directors
	Years of establishment of the company	FirmAge	In (year of establishment+1)
	Proportion of fixed assets	Fixed	Ratio of net fixed assets to total assets
	Book to Market Ratio	BM	Book value/total value

Adjusting variable: Corporate reputation.Corporate reputation is an intangible asset of a company and an important driving factor for its success. Corporate reputation is a psychological transformation process that causes public perception, and is the sum of the ability of corporate behavior to gain social recognition, thereby obtaining resources, opportunities, and support, and ultimately completing value creation. Miao Rong and Mao Ning (2003) [31] believe that a company's reputation is the degree to which it receives trust and praise from the public, usually composed of popularity, reputation, and trust. Corporate reputation is a natural form of social interaction between a company and its public (mainly customers, collaborators, investors, employees, government, news industry, etc.). It is the result of the interaction between the company's behavioral ability and public awareness. This article uses the number of positive and negative news reports of a company as the basis for measuring corporate reputation.

Model construction

In order to study the impact of green investment on company performance and better control the endogenous problems in the empirical study, this paper constructs a panel fixed effect model based on the data of heavily polluted industries from 2008 to 2020:

$$ROAit= \alpha\ 0+ \alpha\ 1\ (lngreenit)+ \lambda\ 1Xit+ \varepsilon\ 1+ \lambda\ I\ \mu\ T \quad (2)$$

In formula (2), the subscripts i and t represent the company and year, respectively. ROA is the dependent variable in the model, and the ROA index is used to measure the performance of the company. Lngreen takes Natural logarithm for Green Investment, 1 for the experimental group affected by Green Investment, and 0 for the control group not affected by Green Investment. Its coefficient α 1 It reflects whether firms make Green Investment, and the difference between the experimental group and the control group in company performance, which reflects the impact of Green Investment on company performance. If the coefficient is positive, it means that Green Investment does not promote company performance; If the coefficient is negative, it means that Green Investment can promote company performance. X represents other control variables, ε_I is a random perturbation term, $\lambda_I \mu_T$ represents individual and temporal control, and the model incorporates fixed effects of company and year to eliminate the potential interference of heterogeneity at the company level and time series on experimental results.

4. 4.Empirical analysis

(1) Descriptive Statistics

From Table 4-1, it can be seen that in the sample companies, the mean ROA is 4.2%, the standard deviation is 0.059, the maximum value is 0.209, and the minimum value is -0.151; The average ROE is 6.4%, the standard deviation is 0.122, the maximum value is 0.351, and the minimum value is -0.527; The mean Q of Tobin is 1.823, with a standard deviation of 1.046, a maximum value of 6.869, and a minimum value of 0.861, indicating significant differences in financial performance among the sample companies; The minimum and maximum values of Green Investment (GI) of firms are 0 and 19.665 respectively, which indicates that the performance of sample companies differs greatly from the level of Green Investment. Therefore, it is of positive significance to explore the impact of Green Investment on company performance. The average size of the company is 22.228, with a standard deviation of 1.325, which fluctuates between 19.981 and 25.966; The mean of financial leverage is 0.436, with a standard deviation of 0.203, ranging from 0.059 to 0.879; The average cash flow from operating activities is 0.057, with a standard deviation of 0.068, fluctuating between -0.136 and 0.233; The average proportion of accounts receivable is 0.084, with a standard deviation of 0.078, fluctuating within the range of 0-0.711; The average proportion of fixed assets is 0.314, with a standard deviation of 0.168, which fluctuates between 0.026 and 0.711; The average value of company growth is 0.14, with a standard deviation of 0.333, fluctuating between -0.469 and 1.827; The average book to market ratio is 1.127, with a standard deviation of 1.087, fluctuating between 0.119 and 5.967; The average age of a company's establishment is 2.818, with a standard deviation of 0.346, which varies between 1.609 and 3.434.

Table 4-1 Descriptive Statistics of Variables

Variable	Obs	Mean	Std. Dev.	Min	Max
ROA	8876	.042	.059	-.151	.209
ROE	8876	.064	.122	-.527	.351
TobinQ	8876	1.823	1.046	.861	6.869
lngreen	8876	2.726	6.125	0	19.665
Size	8876	22.228	1.325	19.981	25.966
Lev	8876	.436	.203	.059	.879
Cashflow	8876	.057	.068	-.136	.233
REC	8876	.084	.078	0	.363
FIXED	8876	.314	.168	.026	.711
Growth	8876	.14	.333	-.469	1.827
Indep	8876	.37	.05	.333	.556
BM	8876	1.127	1.087	.119	5.967
FirmAge	8876	2.818	.346	1.609	3.434

(1) Correlation analysis

In order to prevent Multicollinearity in the model, this paper analyzes the correlation between variables. Table 4-2 shows that the Pearson correlation coefficient between variables is relatively low, and the majority of the data does not exceed 0.8, indicating that there is no obvious collinearity problem.

Table 4-2 Correlation Statistics

Variables	(1)	(2)	(3)	(4)	(5)	(6)
(1) ROA	1.000					
(2) ROE	0.903***	1.000				
	(0.000)					
(3) TobinQ	0.160***	0.077***	1.000			
	(0.000)	(0.000)				
(4) lngreen	-0.032***	-0.015	-0.086***	1.000		
	(0.002)	(0.168)	(0.000)			
(5) Size	-0.043***	0.065***	-0.407***	0.165***	1.000	
	(0.000)	(0.000)	(0.000)	(0.000)		
(6) Lev	-0.447***	-0.290***	-0.233***	0.108***	0.472***	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	
(7) Cashflow	0.408***	0.361***	0.058***	0.016	0.148***	-0.093***
	(0.000)	(0.000)	(0.000)	(0.123)	(0.000)	(0.000)
(8) REC	0.036***	0.018*	0.061***	-0.090***	-0.332***	-0.138***
	(0.001)	(0.091)	(0.000)	(0.000)	(0.000)	(0.000)
(9) FIXED	-0.223***	-0.132***	-0.213***	0.117***	0.331***	0.387***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
(10) Growth	0.280***	0.298***	0.004	0.002	0.040***	0.023**
	(0.000)	(0.000)	(0.696)	(0.849)	(0.000)	(0.032)
(11) Indep	-0.007	-0.010	0.042***	-0.017	-0.005	-0.036***
	(0.482)	(0.344)	(0.000)	(0.112)	(0.628)	(0.001)
(12) BM	-0.304***	-0.200***	-0.498***	0.140***	0.652***	0.574***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)
(13) FirmAge	-0.109***	-0.074***	0.039***	0.094***	0.165***	0.118***
	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)	(0.000)

Variables	(7)	(8)	(9)	(10)	(11)	(12)	(13)
(1) ROA							
(2) ROE							
(3) TobinQ							
(4) lngreen							
(5) Size							
(6) Lev							
(7) Cashflow	1.000						
(8) REC	-0.204***	1.000					

	(0.000)						
(9) FIXED	0.200***	-0.341***	1.000				
	(0.000)	(0.000)					
(10) Growth	0.024**	0.065***	-0.053***	1.000			
	(0.022)	(0.000)	(0.000)				
(11) Indep	-0.012	0.018*	-0.057***	0.020*	1.000		
	(0.275)	(0.095)	(0.000)	(0.062)			
(12) BM	-0.018*	-0.223***	0.375***	-0.054***	-0.022**	1.000	
	(0.097)	(0.000)	(0.000)	(0.000)	(0.034)		
(13) FirmAge	0.053***	-0.062***	0.086***	-0.080***	0.032***	0.165***	1.000
	(0.000)	(0.000)	(0.000)	(0.000)	(0.003)	(0.000)	

(2) Analysis of benchmark regression results

Table 4-3 shows the results of double difference estimation of the impact of Green Investment on company performance. Among them, column (1) does not include control variables, and the regression coefficient of the independent variable is 0.000237, which is significant, indicating that Green Investment can promote the improvement of company performance. In column (2) of Table 4-3, this paper adds relevant control variables to the regression model, and the coefficient result of the independent variable is still positive, 0.000209, and passed the significance test at the 5% level, It means that every change in Green Investment will bring 0.005 (coefficient of core independent variable/mean value of dependent variable, i.e. 0.000209/0.042) units of impact on company performance. In conclusion, the benchmark regression results prove that Green Investment is conducive to improving the performance of firms, and this conclusion verifies the hypothesis H1 proposed in this paper.

Table 4-3 Impact of Green Investment on company performance

	(1)		(2)
	m1		m10
VARIABLES	ROA	VARIABLES	ROA
lngreen	0.000237*	lngreen	0.000209**
	(0.000137)		(0.000100)
Size		Size	0.0134***
			(0.00215)
Lev		Lev	-0.140***
			(0.00745)
Cashflow		Cashflow	0.206***
			(0.0132)
REC		REC	0.0552***
			(0.0200)
FIXED		FIXED	-0.0655***
			(0.00777)
Growth		Growth	0.0360***
			(0.00183)
Indep		Indep	-0.0221
			(0.0165)
BM		BM	-0.0118***
			(0.00117)
FirmAge		FirmAge	-0.0278**
			(0.0116)
Constant	0.0410***	Constant	-0.0963*
	(0.000377)		(0.0537)
Observations	8,752	Observations	8,752
R-squared	0.492	R-squared	0.663
Firm Fe	Yes	Firm Fe	Yes
Year Fe	Yes	Year Fe	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(3) Robustness testing

In order to further verify the analysis conclusions of this paper, after examining the impact of Green Investment on company performance, we use the results in Table 4-3 as the benchmark model, and use the dependent variable replacement method, the replacement sample period method, and the replacement sample method to conduct a robustness test for all company methods.

1. Replace the dependent variable

Replace the explanatory variable with ROE, and examine the impact of Green Investment firms on ROE. The regression results show that Green Investment is significant at the level of 1%, and has a significant positive impact on company performance, which further verifies the robustness of the results.

Table 4-4 Replacing Dependent Variables

	(1)	(2)
	p1	p2
VARIABLES	ROE	ROE
lngreen	0.000561*	0.000462*
	(0.000316)	(0.000245)
Size		0.0394***
		(0.00541)
Lev		-0.269***
		(0.0211)
Cashflow		0.402***
		(0.0290)
REC		0.164***
		(0.0454)
FIXED		-0.104***
		(0.0187)
Growth		0.0796***
		(0.00410)
Indep		-0.0596
		(0.0421)
BM		-0.0301***
		(0.00309)
FirmAge		-0.0253
		(0.0233)
Constant	0.0625***	-0.582***
	(0.000866)	(0.127)
Observations	8,752	8,752
R-squared	0.387	0.551
Firm Fe	Yes	Yes
Year Fe	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

2. Change sample period

Considering that the impact of the COVID-19 in 2020 will bring about a downturn in the overall economy, which will affect the observation of the impact of Green Investment activities on company performance. Therefore, the sample data in 2020 affected by the COVID-19 epidemic was excluded. The regression result is still significantly positive, indicating that the impact of Green Investment on company performance is robust.

Table 4-5 Sample Replacement Period

VARIABLES	(1) w1 ROA
lngreen	0.000196*
	(0.000108)
Size	0.0134***
	(0.00234)
Lev	-0.139***
	(0.00799)
Cashflow	0.201***
	(0.0136)
REC	0.0576***
	(0.0213)
FIXED	-0.0641***
	(0.00807)
Growth	0.0341***
	(0.00187)
Indep	-0.0231
	(0.0168)
BM	-0.0121***
	(0.00124)
FirmAge	-0.0307**
	(0.0128)
Constant	-0.0880
	(0.0596)
Observations	7,919
R-squared	0.668
Firm Fe	Yes
Year Fe	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

3. Replace the sample with all companies

In order to further test whether the conclusion is robust, the sample data is expanded to all listed companies (including non heavily polluting companies). The regression results show that under a 5% probability, Green Investment of all listed companies has a positive impact on company performance. The results are still significant, but the coefficient is smaller, indicating that the impact of Green Investment on company performance is more obvious in heavily polluting industries.

Table 4-6 Replacing Samples for All Companies

VARIABLES	(1) q1 ROA
lngreen	0.000172**
	(7.11e-05)
Size	0.0152***
	(0.00115)
Lev	-0.145***
	(0.00430)
Cashflow	0.161***
	(0.00683)
REC	0.0383***
	(0.00898)
FIXED	-0.0731***
	(0.00520)
Growth	0.0327***
	(0.000959)
Indep	-0.00688
	(0.0101)
BM	-0.00824***
	(0.000687)
FirmAge	-0.0282***
	(0.00599)
Constant	-0.142***
	(0.0291)
Observations	31,952
R-squared	0.618
Firm Fe	Yes
Year Fe	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(2) Heterogeneity analysis

Generally speaking, firms with different property rights will have different investment in green development, so the positive impact of Green Investment of firms with different property rights on company performance will also be different. Taking state-owned and non-state-owned firms as examples, under implicit government guarantees, state-owned holding listed companies have higher financing efficiency and generally lower operating pressure in the capital market. However, non-state-owned listed companies, due to less government support, face greater financing pressure than state-owned holding firms to some extent. Their investment in green development may be lower than that of state-owned firms, and their financing costs may be higher, resulting in less significant performance improvement than state-owned firms. The regression results are shown in Tables 4-7. (1) are the heterogeneity detection results of state-owned listed companies, and (2) are the heterogeneity monitoring results of non-state-owned listed companies, further verifying the correctness of hypothesis H1b.

Table 4-7 Heterogeneity of Property Rights

VARIABLES	(1) h1 ROA	(2) h2 ROA
lngreen	2.65e-05	0.000360**
	(0.000127)	(0.000157)
Size	0.00868***	0.0212***
	(0.00295)	(0.00304)
Lev	-0.128***	-0.137***
	(0.0117)	(0.0101)
Cashflow	0.243***	0.175***
	(0.0222)	(0.0162)
REC	-0.00500	0.0895***
	(0.0306)	(0.0260)
FIXED	-0.0469***	-0.0839***
	(0.0108)	(0.0105)
Growth	0.0315***	0.0356***
	(0.00243)	(0.00259)
Indep	-0.0208	-0.0218
	(0.0240)	(0.0214)
BM	-0.0111***	-0.0211***
	(0.00125)	(0.00292)
FirmAge	-0.0166	-0.0283*
	(0.0207)	(0.0147)
Constant	-0.0294	-0.260***
	(0.0920)	(0.0696)
Observations	3,781	4,946
R-squared	0.671	0.658
Firm Fe	Yes	Yes
Year Fe	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

(3) Analysis of impact mechanism

This article selects corporate reputation as the moderating variable and adds reputation variables to the original model to construct a moderating effect model. To explore whether the heavily polluting industries with Green Investment from 2008 to 2020 have a positive impact on company performance. As shown in the assumptions H2 and H3 in this paper, this paper believes that Green Investment can bring good reputation to firms, thus attracting investment from external stakeholders, thereby helping firms carry out green research and development, and promoting the increase of company performance.

Drawing on the research method of regulatory effects, this article refers to the approach of Song Wenfei et al. [32] to measure the level of corporate reputation based on the number of positive and negative news reports. The model is as follows: $ROA_{it} = \alpha_2 + \beta lngreeni，t + \varphi lngreeni，t \times Reputation + \eta\ Reputation + \gamma X_{it} + \mu_i + \lambda_t + \varepsilon_{it}$ （3）

Wherein, Reputation is the reputation of the heavy pollution industry, ROAi, t is the performance of the listed company i in the heavy pollution industry in year t, and lngreeni, t is the explanatory variable for measuring the Green Investment level of the listed company i in the heavy pollution industry in year t. If the coefficient in front of the double cross multiplication term is significantly positive, then it shows that Green Investment and corporate reputation have synergistic effects on corporate performance. In other words, in industries with a higher degree of Green Investment, the improvement of corporate reputation will have a more obvious effect on corporate performance.

Test whether reputation is the impact mechanism of Green Investment level of listed companies in heavy pollution industries to promote company performance through formula (3). The test results are shown in Table 4-8. The (1) list shows the results of the intermediary mechanism test through positive and negative news reports of firms. The results of column (1) show that Green Investment can have a significant impact on corporate reputation at the level of 1%. This conclusion validates the hypothesis H2 proposed in this paper, that is, heavily polluting listed companies can enhance their reputation and improve their performance through Green Investment.

Table 4-8 Test Results of Reputation as an Impact Mechanism

	(1)	(2)
	r1	r2
VARIABLES	reputation	ROA
lngreen	0.00700***	
	(0.00266)	
PR		7.24e-05**
		(3.14e-05)
Size	1.087***	0.00593***
	(0.113)	(0.00201)
Lev	-0.301	-0.0771***
	(0.186)	(0.00692)
Cashflow	1.923***	0.158***
	(0.233)	(0.0115)
REC	1.586***	0.0371**
	(0.466)	(0.0181)
FIXED	-0.564**	-0.0433***
	(0.270)	(0.00652)
Growth	0.374***	0.0227***
	(0.0431)	(0.00164)
Indep	-0.987**	-0.0134
	(0.405)	(0.0132)
BM	-0.328***	-0.0119***
	(0.0330)	(0.00105)
FirmAge	0.843**	-0.0360***
	(0.333)	(0.0109)
Constant	-19.34***	0.0692
	(2.156)	(0.0505)
Observations	6,817	6,817
R-squared	0.937	0.672
Firm Fe	Yes	Yes
Year Fe	Yes	Yes

Robust standard errors in parentheses
*** p<0.01, ** p<0.05, * p<0.1

The above results show that reputation is indeed the impact mechanism of Green Investment on corporate performance of listed companies in heavily polluted industries, that is, listed companies in heavily polluted industries can improve their own performance by positively affecting the reputation of listed companies in heavily polluted industries.

5. Conclusion and limitation

This paper uses the listed companies in the heavy pollution industry from 2008 to 2020 as the research sample, constructs a panel fixed effect model, and explores the impact of Green Investment on corporate performance. The conclusions are as follows: First, firms' Green Investment is conducive to promoting company performance. This conclusion still holds after a series of robustness tests such

as benchmark regression analysis, sample period replacement, dependent variable replacement, and sample replacement for all companies. Secondly, green investment varies among firms with different property rights, specifically manifested as state-owned firms having a more significant impact on corporate performance than non-state-owned firms. Third, Green Investment further improves corporate performance by improving corporate reputation. By increasing investment in green development of firms, listed companies in heavy pollution industries have complied with China's sustainable development strategy of "Clear waters and green mountains", met the requirements of environmental regulation, won positive reports from the media, improved the public image of firms, further improved the reputation of firms, and external investors are willing to provide financial support for them, thus promoting the improvement of company performance and helping firms achieve sustainable development.

Based on the above conclusions, this article proposes the following policy recommendations: firstly, to regulate and adjust environmental policies appropriately, establish a climate resilient green finance market system, institutional system, and product system, accelerate the construction of green finance infrastructure, trading market, and rule and standard system, cultivate professional service institutions, strengthen investor education, and promote green transformation of firms, Give full play to the positive effect of Green Investment on company performance. Secondly, the state should increase its support for green development for non-state-owned firms, trial different tax preferential policies for firms with different asset structures, actively promote green innovative activities of non-state-owned firms, and promote their own competitive advantages. Third, strengthen the publicity of green firms and give subsidies to these firms, further enhance their popularity and reputation by taking the large proportion of Green Investment as the benchmark, encourage heavy pollution industries to follow these excellent firms, enhance their environmental awareness and social responsibility, guide firms to fully implement their environmental responsibility, and build new green firms, So as to better play the role of Green Investment in improving corporate reputation and promoting corporate performance, and promote the sustainable development of heavy pollution industries.

The research conclusions of this paper provide an empirical basis for the relationship between Green Investment and company performance, enrich relevant literature, and provide some reference for in-depth understanding and understanding of the impact of Green Investment on company performance. However, this article also has certain limitations and does not consider endogeneity issues. For example, if there is an error between the values of the explanatory variables used in the model and the actual values, then endogeneity issues arise; And the research has not been carried out from the perspective of quasi Natural experiment, and there is also a lack of mechanism to test the internal management and external supervision of firms, which is also a problem that the author needs to focus on in the future.

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