

*Original Research*

# Do Chain Directors' Green Experiences Increase Corporate Environmental Investment?

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*Received: 3 February 2024*

*Accepted: 13 September 2024*

## Abstract

Based on the data of China's A-share listed companies from 2008 to 2021, this paper examines the impact of chain directors with green experience on corporate environmental protection investment and concludes that chain directors with green experience can significantly increase corporate environmental protection investment, which is still valid after the robustness test and dealing with the endogeneity problem. The impact mechanism test finds that the green experience chain board increases the environmental investment of enterprises through two channels: increasing the environmental awareness of corporate executives and alleviating the corporate financing constraints. When a company is the subject of considerable external scrutiny, the positive impact of green experience on the company's environmental protection investment will be amplified. From the perspective of enterprise characteristics, state-owned enterprises and enterprises in the eastern region have larger internal capital scale and stronger turnover capacity, which is conducive to the promotion of environmental protection investment by directors with green experience; compared with enterprises without environmental penalties, enterprises with environmental penalties face greater pressure of environmental regulation, which prompts directors with green experience to play a more active role in increasing environmental protection investment.

**Keywords:** chain directors, green experience, environmental inputs

## Introduction

In recent years, with rapid economic development, pollution has become an increasingly serious challenge. The macro-level pollution challenge is mainly manifested in the micro-level enterprise pollution. Investment in environmental protection is regarded as

a necessary way for enterprises to control pollution and assume environmental responsibility. In this context, it is crucial to stimulate the enthusiasm of enterprises' environmental protection investment and increase their environmental protection input. The current scholars' research on enterprise environmental protection investment mainly focuses on two aspects: one is some external influences such as institutional regulation, lawmaking, social public opinion, information environment, etc. The other is internal influences such as

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enterprise business performance, corporate governance, corporate executives, and so on.

In terms of external influences. One is the regulatory aspect of the system. When enterprises face weak external environmental regulation, they may ignore environmental protection investment, and when the government increases the intensity of environmental regulation and pays attention to environmental protection, enterprises will comply with the policy requirements to improve the environmental protection investment. When the government increases the intensity of environmental regulation and emphasizes environmental protection, enterprises will respond to the policy requirements to increase environmental investment [1]. Some scholars have also found that the relationship between corporate environmental investment and the strength of environmental regulation is a kind of inverted U-shaped relationship, that is to say, the government's environmental regulation for the impact of corporate environmental investment is not a straight line, but there is a certain critical value. When the strength of external environmental regulation exceeds a certain critical point, enterprises find that the cost of their environmental investment is higher than the cost of violating the government's environmental policy and would rather bear the government's environmental pollution penalties [2]. The other is the government incentives. In the absence of government policy, institutional incentives, or resource subsidies, enterprises are rarely able to take the initiative in environmental protection innovation and environmental protection management. This is due to the difference between environmental protection investment and other aspects of the enterprise's investment; as long-term work, investment in environmental protection is more difficult to bring economic benefits in the short term [3]. Third, social supervision. Media monitoring as a kind of informal system for the government and business behavior has a certain impact; at the same time, it is also one of the important factors affecting enterprises to fulfill environmental responsibility [4]. Media monitoring as an informal system has a certain influence on the behavior of government and enterprises and is also one of the important factors influencing enterprises to fulfill their environmental responsibility. Consumers' environmental awareness as an informal system can have a positive effect on the improvement of corporate environmental behavior [5]. Fourth, in terms of the information environment, the transparency of environmental information disclosure helps to increase the scale of enterprises' environmental protection investment [6-8].

In terms of internal influences. One is the aspect of enterprise executives' characteristics. Enterprise executives are the main force in enterprise strategic decision-making; their professional background, education, age, and other personal factors will affect the enterprise's decision-making behavior and specific performance. The enterprise's environmental protection

investment decisions are influenced by the personal characteristics of executives, such as their personal values or their preference for the environment. The more the executives emphasize environmental protection, the more they can play a role in the decision-making of environmental protection inputs [9]. The second is the aspect of corporate governance. The external image of the enterprise, such as the image of public welfare and charity, will have an impact on the enterprise's behavior because once the enterprise has a major environmental pollution problem, the image of the enterprise will be damaged, the enterprise's revenue will be lost, and the managers will be held accountable. Therefore, managers will avoid the occurrence of major pollution phenomena by increasing the efforts of corporate environmental protection investment [10]. The third is the aspect of enterprise business performance. As environmental protection investment is a long-term project, only those enterprises with large production scale and more funds can ensure that it does not affect the subsequent production and operation activities, and enterprises are more willing to invest in environmental protection funds [11]. Enterprises with larger scales and higher economic performance pay more attention to the development of environmental protection strategies and the fulfillment of environmental protection responsibility [12, 13]. The larger the enterprise and the higher its economic performance, the more importance it attaches to the formulation of environmental strategy and the fulfillment of environmental responsibility.

It can be seen that scholars have carried out a lot of research on the factors affecting the environmental investment of enterprises and formed a relatively rich result. However, further research is needed to discuss the factors affecting corporate environmental investment from an internal perspective. Although some scholars have paid attention to the impact of corporate executive characteristics on corporate environmental investment, they have not yet paid attention to the impact of chain directors' green experience on corporate environmental investment. Moreover, the key to stimulating the enterprise environmental protection investment is to enhance the motivation of enterprises to actively carry out environmental protection work, which needs to solve the information asymmetry and financing constraints faced by the enterprise environmental protection investment, which are two important reasons that restrict the investment of enterprises in environmental protection. In order to overcome these constraints, enterprises need to actively obtain information and resources from the outside to promote environmental protection investment. How can enterprises obtain information and resources from outside to alleviate information asymmetry and financing constraints? Resource Dependence Theory [14, 15] provides new perspectives and ideas to solve the problem. According to resource dependence theory, chain directors are an important channel for enterprises to obtain information and resources from the outside [16, 17]. The chain

director is an important channel for enterprises to obtain information and resources from external sources. So, will the human capital and social capital related to green development and environmental protection possessed by chain directors with green experience help enterprises obtain information and resources from the outside to promote their environmental protection investment? How can they help enterprises increase environmental investment by alleviating the limitations of information asymmetry and financing constraints? Exploring these issues will help provide feasible solutions to increase corporate environmental investment from the perspective of corporate governance, thus stimulating the motivation for green development of enterprises, improving the level of green development of enterprises, and then promoting the whole society to embark on the road of green development.

The main contributions of this paper are as follows: Firstly, this paper presents a theoretical framework for the influence of green experience among chain directors on corporate environmental protection investment. Two hypotheses are proposed: (1) chain directors with green experience exert a significant positive impact on corporate environmental protection investment, and (2) when external attention to the enterprise is high, the effect of green experience among chain directors on corporate environmental protection investment is enhanced. Secondly, this paper empirically tests the hypotheses using data from Chinese listed companies. Finally, based on the findings of this study, recommendations for potential future actions are put forth.

## Material and Methods

### Theoretical Analysis and Research Hypotheses

Previous research has examined the impact of interlocking directorships on enterprises based on the resource dependence theory. This research has found that the human capital and social capital possessed by the board of directors help enterprises obtain scarce resources and important information from the outside. The term 'human capital' is used to describe the experience, knowledge, and expertise of directors. This includes their understanding of a particular industry and familiarity with specific events. These experiences influence the focus of the directors' attention and the manner in which they make decisions. The term 'social capital' is used to describe the resources that directors can access through their network of relationships, both within and outside the company. Consequently, interlocking directorships facilitate the exchange of resources and information between enterprises, representing a significant conduit for the acquisition of dependable and cost-effective resources and information from external sources.

Based on the above analysis, chain directors with green experience become an important channel for enterprises to obtain information and resources on environmental protection inputs from the outside. On one hand, chain directors with green experience may pay more attention to information on environmental protection inputs and can pay more timely attention to relevant issues in the field of environmental protection, and they have more specialized knowledge and ability in green development, and the information and resources brought by them are more valuable and professional; On the other hand, chain directors with green experience can help enterprises obtain more resources, such as green credit. Chain directors with green experience can help enterprises obtain professional knowledge, key information, and scarce resources in all aspects of environmental protection input activities from the outside and provide an optimized path for enterprises to effectively allocate and utilize environmental protection resources, thus increasing the willingness and ability of enterprises to independently participate in green environmental protection input. The specific analysis is as follows:

Chain directors with green experience provide a channel for enterprises to obtain green innovation knowledge and information from the outside, reducing the limitations of information asymmetry on environmental investment. With their human capital and social capital, green experience chain directors are not only more sensitive to the issue of environmental investment, but also have more external network channels, which can more fully understand and perceive the expectations of stakeholders for the enterprise to actively carry out environmental investment activities and thus are more conducive to the enterprise's access to external knowledge and information on environmental investment. In addition, the green experiences they have will also make the enterprises pay more attention to environmental issues when carrying out innovative activities, as the higher-order theory [18] suggests that the traits formed by executives' past education and work experience will affect their attention tendency to a certain extent, implying that the green experiences possessed by chain directors will make them more aware of the importance of environmental protection to the sustainable development of enterprises and have a stronger awareness of environmental protection and social responsibility [19]. Therefore, it is said that the green experience of chain directors can help enterprises identify the potential benefits and market opportunities of green development by enhancing the environmental awareness of executives and promoting enterprises to carry out more environmental investment activities.

Chain directors with green experience can help enterprises access resources to alleviate financing constraints through information and resource effects. On the one hand, as green experience chain directors have a large number of important and beneficial business connections, such as customers, suppliers,

and government agencies, the willingness and behavior of enterprises to actively pursue green innovation can be widely disseminated through the network of chain directors [20]. This will help transmit the information about green innovation activities to the capital market, which can effectively alleviate the information asymmetry faced by enterprises when applying for green credit, help enterprises obtain larger-scale green loans, lower financing costs, and longer loan terms, and promote green corporate governance [21]. It also helps enterprises improve the level of environmental protection investment. On the other hand, the green experience chain of directors through the resource effect helps enterprises broaden the external financing channels. Enterprises can not only communicate with the outside world more effectively through the network of directors established by the chain of directors with green experience, but also the more enterprises linked in the network of directors, the more commercial credit the enterprise receives, and it is easier to obtain the trust of creditors, thus reducing the communication cost between creditors and enterprises. It can be seen that chain directors make the linked enterprises more trustful to each other, which is conducive to matching more external capital providers, broadening financing channels, weakening the difficulty of external financing constraints, and lowering financing costs. Therefore, enterprises can obtain funds for environmental protection investment through chain directors with green experience, reduce the constraints of financing constraints on environmental protection investment, and thus promote the increase of enterprise environmental protection investment. Based on this, this paper proposes:

Hypothesis 1: There is a significant positive effect of having green experience chain directors on the increase of corporate environmental investment.

In the context of a high level of external attention to the company, the impact of green experience chain directors on increasing the company's environmental protection investment is likely to be enhanced. Firstly, it is necessary to enhance transparency and credibility in the dissemination of information. In the event of a high level of external attention to the company, any decision or action taken by the company will become the focus of public and investor attention. In such circumstances, the involvement of green experience chain directors can facilitate the acquisition of more expedient data regarding environmental protection investment while simultaneously enhancing the transparency and credibility of this information through the utilization of their expertise and experience. The high level of information transparency and credibility helps companies establish a green and environmentally friendly public image, thereby compelling them to invest in environmental protection. Secondly, it serves to enhance the company's sense of social responsibility. In an environment where external attention is high, enterprises are more likely to fulfill their social

responsibilities. Green directors, with their heightened awareness of environmental protection and social responsibility, can motivate enterprises to engage more actively in environmental protection activities, thereby aligning their actions with the expectations of external stakeholders. This positive response serves to enhance the social recognition and support that companies receive, as well as encourage them to invest in environmental protection. Thirdly, it facilitates the integration and optimization of external resources. In a context of heightened external scrutiny, green experience chain directors are better positioned to integrate and optimize external resources, such as green credit and government subsidies, through their extensive social networks and business contacts. The acquisition of these resources not only reduces the cost of the enterprise's environmental investment, but also improves the efficiency of the enterprise's environmental investment, ensuring that the enterprise's environmental investment can be carried out smoothly. Therefore, this paper proposes the following hypothesis:

Hypothesis 2: When there is a high level of external attention to the enterprise, the effect of green experience chain directors on increasing the enterprise's environmental protection investment will be strengthened.

## Research Sample and Data

This paper selects the data of Chinese A-share listed companies from 2008 to 2021. The samples are screened and processed as follows: First, ST and \*ST companies are excluded; second, the study samples with missing main data are excluded; third, financial companies and companies engaged in financial businesses are excluded. The data of chain directors with green experience are collected manually, and the specific process is as follows: First, define directors who simultaneously serve on the executive team, board of directors, or supervisory boards of different enterprises as chain directors, and screen the list of chain directors of listed companies according to the above criteria; second, utilize the terms "green", "environmental", and "environmental protection", "environmental", "environment", "sustainable", "recycling", "reuse", "waste water", "Sewage", "pollution", "greening", "regeneration", "ecological", "energy saving", and other keywords [22], were screened in the chain director resume information database to identify chain directors with green work experience or educational background. Data for all other variables were obtained from the China Stock Market & Accounting Research Database (CSMAR).

## Modeling

Based on the above theoretical analysis of the environmental investment of companies by chain directors with green experience, the econometric model is set as follows:

Table 1. Definitions of main variables.

Variable type	Variable name	Variable symbol	Calculation method
Explanatory variable	Corporate environmental investment	EPI	Logarithmic scale of corporate environmental investment
Explanatory variable	Chain of directors with green experience	Green	Number of chain directors with green work experience or educational backgrounds
Control variable	Return on assets	ROA	Return on business assets
	Age of business	Firmage	Time elapsed since the establishment of the enterprise
	Enterprise size	Firmsize	Logarithmic number of employees in the enterprise
	Gearing	Leverage	Total liabilities divided by total assets
	Board size	Boardsize	Number of directors on the board
	Board independence	Independent	Ratio of the number of independent directors to the total number of board members
	Shareholding concentration	Ownership	Shareholding ratio of top ten shareholders
	Chain of directors with green experience network position	Centrality	The intermediary center degree of enterprises with green experience chain directors in that year takes the average value * 100
	Nationalized business	Stateown	1 for state-owned enterprises, 0 for non-state-owned enterprises
Mechanism variables	Executive Environmental Awareness	GreenAware	Total word frequency of environmentally related terms as a percentage of total word frequency of MD&A
	Credit facility	Loan	The sum of long-term borrowings and short-term borrowings at the end of the period is logarithmic.

$$EPI_{it} = \alpha_0 + \alpha_1 Green_{it} + \sum_j \beta_j X_{ijt} + \varepsilon \quad (1)$$

Where  $EPI_{it}$  represents the level of environmental protection investment of firms;  $Green_{it}$  represents the number of chain directors with green experience on the board of directors of firms;  $X_{ijt}$  denotes a series of control variables, and  $\varepsilon$  denotes a random error term. The definitions of specific variables are shown in Table 1.

## Result and Discussion

### Descriptive Statistical Analysis

The core explanatory variables and the explanatory variables of this paper are mainly analyzed here. The descriptive statistical results of the variables are shown in Table 2. The mean value of  $EPI$  is 1.1053, and the standard deviation is 4.0765, respectively, indicating that the amount of environmental protection inputs of the sample enterprises is less overall and varies greatly. The mean value of  $Green$  is 0.1018, with a minimum of 0 and a maximum of 6, indicating that the number of the sample enterprises with green experience chain directors is less overall. The standard deviation of  $Green$  is 0.4532, indicating that there is some difference in the number of enterprises with green experience chain directors, which provides the possibility of identifying

the causal relationship between the core explanatory variables and the explained variables.

### Analysis of Baseline Regression Results

Table 3 shows the regression results of the effect of chain directors with green experience on corporate environmental investment. According to the results in columns (1), (2), and (3), the coefficients of  $Green$  are 0.5415, 0.5424, and 0.2723, respectively, and all of them are significantly at the 1% level, indicating that chain directors with green experience can increase the environmental protection investment of enterprises, and hypothesis 1 is supported.

### Robustness Testing

Considering the potential endogeneity problem of self-selection bias in hiring chain directors with green experience in Chinese listed companies, this paper adopts the Heckman two-stage model to deal with the endogeneity problem, and the estimation results are shown in Table 4, where  $Green\_D$  denotes the dummy variable generated according to the magnitude of  $Green$  value. As can be seen from the results, the regression coefficient of  $IMR$  passes the significance test, indicating that the selection model adopted in this paper is appropriate and effectively controls the potential self-selection bias problem. Meanwhile, the coefficient of



Table 2 . Descriptive statistics of variables.

Variable	Obs	Mean	Std. Dev.	Min	Max.
<i>EPI</i>	16475	1.1053	4.0765	0.0000	22.8088
<i>Green</i>	16475	0.1018	0.4532	0.0000	6.0000
<i>ROA</i>	16475	0.0480	0.0668	-0.3358	0.2406
<i>Firmage</i>	16475	16.4551	5.9312	2.0000	32.0000
<i>Firmsize</i>	16475	7.8005	1.2021	3.7136	11.0958
<i>Leverage</i>	16475	0.4077	0.2000	0.0565	0.9360
<i>Boardsize</i>	16475	8.5333	1.6470	5.0000	15.0000
<i>Independent</i>	16475	0.3750	0.0540	0.1818	0.5714
<i>Centrality</i>	16475	0.0173	0.0782	0.0000	1.7038
<i>Ownership</i>	16475	0.6051	0.1541	0.2222	0.9546
<i>Stateown</i>	16475	0.2738	0.4460	0.0000	1.0000
<i>GreenAware</i>	16475	0.0007	0.0009	0.0000	0.0373
<i>Loan</i>	16475	13.7910	9.7076	0.0000	26.7014

Green is significantly positive at the 1% level, which is consistent with the results in Table 3. Hypothesis 1 is proved again.

To further test the robustness of the benchmark results, the paper makes a series of substitutions to the main variables in Table 3. First, the independent variable is replaced from the number of chain directors with green experience to the percentage of board seats held by chain directors with green experience (*Green\_Ratio*) for regression analysis, and the estimation results are shown in column (1) of Table 5. It can be found that the larger the proportion of directors with a green experience chain, the more environmental protection investment of enterprises, and passed the significance test at the 1% level, which is consistent with the results presented in Table 3. Second, in order to mitigate the impact of the level of corporate environmental investment, this paper adopts corporate environmental investment per capita (*EPI\_Ratio*) to measure corporate environmental investment, and the estimation results are shown in column (2) of Table 5. The results show that the coefficient of Green is significantly positive, which indicates that having green experience chain directors can increase corporate environmental investment. This shows that the results in Table 3 are robust.

### Mechanism of Action Test

As pointed out in the theoretical analysis section above, the board of directors of a chain with green experience increases the environmental investment of enterprises through two channels: increasing the environmental awareness of corporate executives and alleviating corporate financing constraints, these two mechanisms are tested here. To this end, the total word frequency of environmentally related words accounted

for the proportion of the total word frequency of management discussion and analysis to construct the corporate executives' environmental awareness index (*GreenAware*); the larger the value of the index indicates that the corporate executives' environmental awareness is stronger. At the same time, the logarithm of the sum of long-term borrowing and short-term borrowing at the end of the period is used to indicate the corporate financing constraint (*Loan*), and the larger the value of this indicator is, the smaller the corporate financing constraint is.

First, the role of corporate executives' environmental awareness is examined, and the estimation results are shown in columns (1)-(2) of Table 6. Column (1) shows that having green experience chain directors increases corporate executives' environmental awareness; column (2) shows that having green experience chain directors can increase corporate environmental investment by increasing corporate executives' environmental awareness, and corporate executives' environmental awareness plays a partially mediating role. This is due to the fact that the environmentally conscious approach of the chain board of directors results in the company developing in a more environmentally conscious manner. This is in accordance with the higher-level theory, which suggests that the characteristics formed by the education and work experience of senior executives in the past will affect their attention tendencies to a certain extent. This implies that the green experience of the chain directors will render them more cognizant of the significance of environmental protection for the sustainable development of the company, thereby engendering a more robust environmental protection sensibility. Consequently, the green experience of the chain directors can assist companies in identifying the potential benefits and market opportunities of

Table 3. Benchmark regression results.

Variables	(1)	(2)	(3)
	EPI	EPI	EPI
Green	0.5415***	0.5424***	0.2723***
	(0.0861)	(0.0866)	(0.0851)
ROA	0.0969	0.1793	-0.1105
	(0.5362)	(0.5399)	(0.5300)
Firmage	0.0379***	0.0310***	0.0214***
	(0.0057)	(0.0064)	(0.0064)
Firmsize	0.1023***	0.0919***	0.1513***
	(0.0316)	(0.0319)	(0.0329)
Leverage	1.3331***	1.3521***	0.7451***
	(0.1973)	(0.1979)	(0.2066)
Boardsize	0.0098	0.0169	0.0323
	(0.0236)	(0.0238)	(0.0235)
Independent	-0.1504	-0.1324	0.9065
	(0.6867)	(0.6865)	(0.6724)
Centrality	-2.4875***	-2.5174***	-1.8875***
	(0.4989)	(0.4994)	(0.4866)
Ownership	-0.2897	-0.2823	-0.4166*
	(0.2198)	(0.2206)	(0.2215)
Stateown	0.3463***	0.3709***	0.3410***
	(0.0797)	(0.0802)	(0.0824)
_cons	-0.8241*	-0.7198	-1.1779***
	(0.4390)	(0.4433)	(0.4453)
YearFE	No	Yes	Yes
IndustryFE	No	No	Yes
N	16475	16475	16475
R <sup>2</sup>	0.0205	0.0223	0.0889

Note: Standard errors in parentheses \*p<0.10", \*\*\*p<0.05", \*\*\*\*p<0.01

environmental protection investment by enhancing the environmental awareness of senior executives, thereby encouraging companies to engage in environmental protection investment activities.

Secondly, we test the role of corporate financing constraint mitigation, and the estimation results are shown in columns (3)-(4) of Table 6. Column (3) shows that chain directors with green experience can alleviate corporate financing constraints; column (4) shows that chain directors with green experience can increase corporate environmental investment by alleviating corporate financing constraints, and corporate financing constraints play a partially mediating role. The long payback period of environmental protection investment has led to a reluctance among executives to invest

in environmental protection due to the shortsighted behavior of "cost-benefit" trade-offs. This has resulted in companies being unable to release and convey information on environmental protection activities to banks before and after loans, making it difficult to obtain green credit resources. This, in turn, has led to financing constraints on companies. The inclusion of directors with green experience in the boardroom can help to alleviate financing constraints on companies by reducing the shortsightedness of executives and actively promoting the implementation of environmental protection investment activities. This, in turn, increases the willingness of banks to provide green credit support. Furthermore, given the expertise and familiarity with green innovation of chain directors with environmental

Table 4. Robustness test: Heckman test.

Variables	(1)	(2)
	Green_D	EPI
Green		0.2778***
		(0.0861)
mills		16.3582*
		(8.3509)
ROA	0.0666	0.6749
	(0.2685)	(0.7143)
Firmage	-0.0088***	-0.1005
	(0.0032)	(0.0629)
Firmsize	0.0570***	0.9512**
	(0.0166)	(0.4075)
Leverage	0.0515	1.4989***
	(0.1089)	(0.4253)
Boardsize	0.0225*	0.3535**
	(0.0120)	(0.1627)
Independent	0.4335	6.9969**
	(0.3455)	(3.1564)
Centrality		-1.9488***
		(0.4933)
Ownership		-0.3524
		(0.2276)
Stateown		0.3420***
		(0.0844)
_cons	-2.7061***	-43.7495**
	(0.4420)	(21.6702)
YearFE	Yes	Yes
IndustryFE	Yes	Yes
N	15858	15858
R <sup>2</sup>	0.0402	0.0884

Note: Standard errors in parentheses \*p<0.10", "\*\*\*p<0.05",  
"\*\*\*\*p<0.01

experience, they are expected to be more proactive in carrying out their regulatory responsibilities. They will actively supervise the use of green credit obtained by senior managers to promote environmental protection investment. This will help banks monitor the use of green loans, their efficiency, and the effectiveness of environmental protection investment. It will also help enterprises receive more green credit resources and alleviate financing constraints.

In order to test the robustness of the mechanism test, this paper employs the lagged one-period value

Table 5. Robustness tests: changing the measure of the variable.

Variables	(1)	(2)
	EPI	EPI_Ratio
Green_Ratio	2.1012***	
	(0.6831)	
Green		0.0330***
		(0.0107)
ROA	-0.1095	-0.0166
	(0.5300)	(0.0667)
Firmage	0.0214***	0.0023***
	(0.0064)	(0.0008)
Firmsize	0.1511***	0.0035
	(0.0330)	(0.0041)
Leverage	0.7482***	0.1055***
	(0.2066)	(0.0260)
Boardsize	0.0350	0.0035
	(0.0235)	(0.0030)
Independent	0.8890	0.0934
	(0.6724)	(0.0847)
Centrality	-1.8167***	-0.2358***
	(0.4798)	(0.0613)
Ownership	-0.4160*	-0.0614**
	(0.2215)	(0.0279)
Stateown	0.3412***	0.0401***
	(0.0824)	(0.0104)
_cons	-1.1931***	-0.0080
	(0.4454)	(0.0561)
YearFE	Yes	Yes
IndustryFE	Yes	Yes
N	16475	16475
R <sup>2</sup>	0.0889	0.0809

Note: Standard errors in parentheses \*p<0.10", "\*\*\*p<0.05",  
"\*\*\*\*p<0.01

of the core explanatory variable as the instrumental variable for the current period and re-estimates it using a two-stage least squares (2SLS) model. The results are presented in Table 7. The results of the mechanism test in this paper are robust.

In order to test the moderating effect of external attention, this section employs the number of analysts following the company in the current year as a proxy variable for external attention (Analysts) and interacts it with the green experience variable of the chain director in order to bring it into the model for estimation. The



Table 6. Mechanism of action tests.

Variables	(1)	(2)	(3)	(4)
	GreenAware	EPI	Loan	EPI
Green	0.0109*** (0.0016)	0.2081** (0.0847)	0.4588*** (0.1717)	0.2677*** (0.0852)
ROA	0.0268*** (0.0101)	-0.2682 (0.5267)	-2.7075** (1.0688)	-0.0829 (0.5300)
Firmage	0.0004*** (0.0001)	0.0193*** (0.0063)	0.0003 (0.0128)	0.0214*** (0.0064)
Firmsize	-0.0016** (0.0006)	0.1606*** (0.0327)	1.6910*** (0.0665)	0.1341*** (0.0336)
Leverage	0.0019 (0.0039)	0.7340*** (0.2053)	18.0564*** (0.4166)	0.5606** (0.2180)
Boardsize	0.0011** (0.0004)	0.0261 (0.0233)	0.1315*** (0.0474)	0.0310 (0.0235)
Independent	-0.0177 (0.0128)	1.0107 (0.6682)	2.2147 (1.3560)	0.8839 (0.6723)
Centrality	-0.0354*** (0.0093)	-1.6789*** (0.4837)	-2.4587** (0.9813)	-1.8624*** (0.4866)
Ownership	-0.0096** (0.0042)	-0.3600 (0.2201)	-3.4328*** (0.4467)	-0.3815* (0.2218)
Stateown	0.0026* (0.0016)	0.3255*** (0.0819)	-0.7984*** (0.1662)	0.3491*** (0.0825)
Loan				0.0102*** (0.0039)
GreenAware		5.8849*** (0.4075)		
_cons	0.0705*** (0.0085)	-1.5928*** (0.4435)	-6.2967*** (0.8981)	-1.1135** (0.4459)
YearFE	Yes	Yes	Yes	Yes
IndustryFE	Yes	Yes	Yes	Yes
N	16475	16475	16475	16475
R <sup>2</sup>	0.2889	0.1004	0.3466	0.0893

results are presented in Table 8. Column (1) of Table 8 does not include control variables, while column (2) includes control variables. The results indicate that the coefficient of the interaction term is significantly positive at the 10% level. This suggests that when external attention to the company is high, the effect of green experience on the increase in environmental protection investment by chain directors will be strengthened.

### Discussion of Heterogeneity

As environmental protection investment requires a larger investment scale and longer investment cycle, the internal capital scale and capital turnover capacity of the enterprise put forward higher requirements. When the enterprise's internal capital is not enough to support environmental protection investment and there are strong external financing constraints, the enterprise will have to delay or give up environmental

Table 7. Mechanism of action tests based on the instrumental variable method.

Variables	(1)	(2)	(3)	(4)
	GreenAware	EPI	Loan	EPI
Green	1.5691***	1.3184***	0.0699***	0.7039***
	(0.5070)	(0.2641)	(0.0056)	(0.2659)
ROA	0.1408	0.5249	0.0706***	-0.1250
	(1.2626)	(0.6567)	(0.0140)	(0.6438)
Firmage	-0.0006	0.0343***	0.0005***	0.0298***
	(0.0150)	(0.0078)	(0.0002)	(0.0076)
Firmsize	1.6007***	0.0531	-0.0065***	0.1460***
	(0.0756)	(0.0401)	(0.0008)	(0.0386)
Leverage	19.8030***	0.9883***	0.0461***	0.9622***
	(0.4648)	(0.2584)	(0.0052)	(0.2372)
Boardsize	0.1677***	0.0154	0.0012*	0.0081
	(0.0556)	(0.0290)	(0.0006)	(0.0283)
Independent	2.5734	-0.0290	-0.0363**	0.3587
	(1.5921)	(0.8282)	(0.0177)	(0.8111)
Centrality	-6.9421***	-5.4624***	-0.2365***	-3.4158***
	(2.0642)	(1.0754)	(0.0229)	(1.0741)
Ownership	-1.7602***	-0.3119	0.0080	-0.4216
	(0.5234)	(0.2724)	(0.0058)	(0.2666)
Stateown	-0.3753**	0.4331***	0.0118***	0.3165***
	(0.1840)	(0.0957)	(0.0020)	(0.0939)
Loan		0.0202***		
		(0.0047)		
GreenAware				9.2485***
				(0.4323)
YearFE	Yes	Yes	Yes	Yes
IndustryFE	Yes	Yes	Yes	Yes
N	12550	12550	12550	12550
R2	0.2650	0.0142	0.0055	0.0547

Note: Standard errors in parentheses \*  $p < 0.10$ ", \*\*\*  $p < 0.05$ ", \*\*\*\*  $p < 0.01$

protection investment. When the external financing constraints have been mitigated, it is equivalent to the environmental protection investment for the enterprise to provide incentives. Relatively speaking, state-owned enterprises and enterprises in the eastern region have an internal capital scale and turnover capacity that are larger and stronger than non-state-owned enterprises and enterprises in the central and western regions, respectively. So is there a difference in the impact of having green experience chain directors on the environmental protection investment of state-owned enterprises and non-state-owned enterprises

and enterprises in the eastern region and the central and western regions? In addition, does whether a firm has been penalized for environmental protection also affect the extent of the role of chain directors with green experience? Based on this, this paper will analyze the heterogeneity in terms of the nature of enterprise ownership, the region where the enterprise is located, and whether it has been penalized for environmental protection.

In this paper, the study sample is divided into six sub-samples of state-owned enterprises and non-state-owned enterprises, enterprises in the eastern region

Table 8. The moderating effect of external attention.

Variables	(1)	(2)
	EPI	EPI
Green	0.2049**	0.4615***
	(0.0928)	(0.1073)
Analysts	-0.0115***	-0.0174***
	(0.0033)	(0.0038)
Green#Analysts	0.0125*	0.0112*
	(0.0067)	(0.0066)
ROA		1.1851**
		(0.5935)
Firmage		0.0343***
		(0.0061)
Firmsize		0.1517***
		(0.0350)
Leverage		1.3858***
		(0.2056)
Boardsize		0.0134
		(0.0248)
Independent		-0.1194
		(0.7173)
Centrality		-2.5696***
		(0.5142)
Ownership		-0.3152
		(0.2279)
Stateown		0.3313***
		(0.0833)
_cons	1.2025***	-1.0955**
	(0.0430)	(0.4661)
YearFE	Yes	Yes
IndustryFE	Yes	Yes
N	15629	15629
R <sup>2</sup>	0.0020	0.0211

and the central and western region, enterprises with environmental penalties, and enterprises without environmental penalties for heterogeneity analysis. From the regression results (see Table 9), it can be seen that having green experience chain directors can significantly increase the environmental protection investment of state-owned enterprises and enterprises in the eastern region, but the impact on the environmental protection investment of non-state-owned enterprises and enterprises in the central and western regions is not

significant, which may be due to the fact that the state-owned enterprises and enterprises in the eastern region have a stronger internal financial strength and turnover capacity, and having green experience chain directors help these enterprises to obtain green development information and resources from the outside, which effectively alleviates the problem of green development of these enterprises. The reason may be that state-owned enterprises and enterprises in the eastern region have a stronger internal financial strength and turnover

Table 9. Discussion results of heterogeneity.

	(1)	(2)	(3)	(4)	(5)	(6)
	Nationalized business	Non-state enterprise	Eastern part	Central and Western region	There are environmental penalties	No environmental penalties
Green	0.9288*** (0.1886)	-0.0129 (0.0926)	0.5046*** (0.1439)	0.1173 (0.1050)	0.2388*** (0.0871)	0.5191 (0.3432)
ROA	-1.2883 (1.4463)	0.4738 (0.5413)	-0.2160 (0.8384)	-0.3414 (0.6851)	0.0687 (0.5262)	-2.8387 (2.8846)
Firmage	0.0091 (0.0159)	0.0249*** (0.0067)	0.0453*** (0.0101)	0.0040 (0.0083)	0.0279*** (0.0064)	-0.0503* (0.0289)
Firmsize	0.1853** (0.0782)	0.1599*** (0.0361)	0.0865 (0.0540)	0.1681*** (0.0422)	0.1561*** (0.0338)	0.0424 (0.1551)
Leverage	0.3467 (0.4905)	0.8355*** (0.2208)	1.2344*** (0.3324)	0.1200 (0.2647)	0.6094*** (0.2060)	1.8054* (1.0403)
Boardsize	0.0748* (0.0446)	0.0127 (0.0284)	-0.0333 (0.0366)	0.0753** (0.0309)	0.0401* (0.0240)	-0.0089 (0.0952)
Independent	0.9116 (1.4293)	0.8074 (0.7759)	-0.1269 (1.0404)	1.1410 (0.8872)	1.0701 (0.6866)	0.0500 (2.7310)
Centrality	-3.8400*** (0.9805)	-0.8557 (0.5511)	-2.3011*** (0.8177)	-1.4083** (0.6013)	-1.7677*** (0.4964)	-1.4514 (1.9457)
Ownership	-0.9852* (0.5363)	-0.3040 (0.2398)	-0.5640* (0.3417)	-0.1884 (0.2956)	-0.4015* (0.2230)	-0.7631 (1.0550)
Stateown	0.0000 (0.0000)	0.0000 (0.0000)	0.1168 (0.1281)	0.5331*** (0.1101)	0.2701*** (0.0836)	0.9304*** (0.3604)
_cons	-0.6909 (0.9373)	-1.2381** (0.5371)	-0.0957 (0.6925)	-1.4471** (0.5928)	-1.4441*** (0.4560)	1.7178 (1.9344)
YearFE	Yes	Yes	Yes	Yes	Yes	Yes
IndustryFE	Yes	Yes	Yes	Yes	Yes	Yes
N	4508	11963	6885	9588	14933	1534
R <sup>2</sup>	0.1345	0.0751	0.1347	0.0817	0.0886	0.1342

capacity, and chain directors with green experience help these enterprises obtain green development information and resources from the outside, which effectively alleviates the limitations of financing constraints on the environmental protection investment of these enterprises, and they will be more capable of and motivated to actively invest in environmental protection, which can promote the state-owned enterprises and enterprises in the eastern region to be more active in environmental protection investment; while non-state-owned enterprises and enterprises in the central and western regions will have to postpone or give up their investment in environmental protection due to their limited internal financial strength and turnover

capacity. Therefore, the role of chain directors in increasing environmental protection investment in these enterprises cannot be played. The regression results based on the collected data on environmental penalties of enterprises show that chain directors with green experience can increase the environmental investment of enterprises with environmental penalties, but the effect on enterprises without environmental penalties is not significant, which may be due to the enterprises that have been subjected to environmental penalties facing greater pressure on environmental governance, which encourages chain directors with green experience to play a substantial role in helping enterprises increase their investment in environmental protection.

## Conclusions

Based on the data of Chinese A-share listed companies from 2008 to 2021, this paper examines the impact of chain directors with green experience on corporate environmental protection investment and concludes that chain directors with green experience can significantly increase corporate environmental protection investment, which is still valid after conducting robustness tests and dealing with endogeneity issues. The impact mechanism test finds that the green experience chain board increases the environmental investment of enterprises through two channels: increasing the environmental awareness of corporate executives and alleviating the corporate financing constraints. When a company is the subject of considerable external scrutiny, the positive impact of green experience on the company's environmental protection investment will be amplified. From the perspective of enterprise characteristics, state-owned enterprises and enterprises in the eastern region have a larger internal capital scale and stronger turnover capacity, which is conducive to the promotion of environmental protection investment by directors with green experience. Compared with enterprises without environmental penalties, enterprises with environmental penalties face greater pressure of environmental regulation, which prompts directors with green experience to play a more active role in increasing environmental protection investment.

The findings of this paper shed some light on how to promote enterprises to increase environmental protection investment. On a micro level, enterprises can employ or establish linkages with other enterprises and organize through chain directors with green experience and then can obtain green development information and resources from the outside, so as to effectively break through the dilemma caused by information asymmetry and financing constraints on enterprises' environmental protection investment. Enterprises also increase the green experience of chain directors to enhance the environmental awareness of the executive team, effectively enhancing the enthusiasm and motivation of the enterprise's environmental investment and encouraging enterprises to actively invest in environmental protection activities. On a macro level, the government should further improve the green financial system, enhance the green credit innovation, and accelerate the solution of those actively engaged in environmental protection investment enterprises as information asymmetry caused by the difficulty of obtaining green loans through the breakthrough of financing constraints on the environmental protection investment constraints to further enhance the enthusiasm of the enterprise environmental protection investment.

Furthermore, the study revealed that external pressure on enterprises can facilitate the active role of directors of green experience chain companies in promoting corporate environmental protection investment. Consequently, the government can enhance

the external scrutiny of enterprises by formulating rational and efficacious policies for evaluating corporate environmental protection investment and encouraging and guiding enterprises to implement environmental protection investment. The Ministry of Education can facilitate the training of more high-end interdisciplinary talents in green development-related majors at universities, thereby effectively increasing the supply of talents with a green education background. Moreover, it can formulate relevant incentive policies to encourage and guide enterprises to pay more attention to and hire high-end talents with a green education background and work experience. This will enable them to make full use of their expertise, key information, and scarce resources to promote high-quality environmental protection investment activities.

## Acknowledgements

This study was supported by National Social Science Fund (24XJY009) and Henan Province Higher Education Teaching Reform Research and Practice Project (2024SJGLX0187).

## Conflict of Interest

The authors declare no conflict of interest.

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