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D&O Insurance and Firms' Environmental Information Disclosure: Evidence from China

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ABSTRACT

This study analyzes the impact of directors' and officers' liability (D&O) insurance on firms' environmental information disclosure quality. Our findings demonstrate that D&O insurance improves environmental information disclosure quality, which aligns with the governance hypothesis. We ensured the reliability of our results by controlling for endogeneity; our results remained consistent across alternative measures and specifications. This effect is particularly pronounced in state-owned enterprises and firms without prior environmental penalties, financial restatements, or audits conducted by the top 10 accounting firms. This study provides important practical implications, suggesting that purchasing D&O insurance significantly enhances enterprises' level of environmental governance.

KEYWORDS

D&O insurance; environmental information disclosure; corporate governance; corporate social responsibility

JEL

G14; G22; G30

1. Introduction

Firms' strategies for environmental protection have gained significant attention because industrial business activities are the primary source of pollution (Lundgren and Zhou 2017; Potrich, Cortimiglia, and de Medeiros 2019; Zhang, Yu, and Kong 2019). This study investigates the correlation between directors' and officers' liability insurance (D&O insurance) and companies' environmental information disclosure. The existing literature mainly discusses D&O insurance as a critical company strategy for protecting directors and senior management (Lin, Officer, Wang and Zou 2013; Lin, Officer, and Zou 2011; Wang, Zhang, Huang, and Zhang 2020; Wynn 2008). Nevertheless, it remains unclear how D&O insurance affects corporate behavior concerning environmental issues and whether it has any effect.[1]

Despite the crucial role of D&O insurance in shaping managers' preferences, previous studies have predominantly concentrated on reducing managers' litigation risks (Chalmers, Dann, and Harford 2002; Core 1997). However, some studies have indicated that companies that purchase D&O insurance are more likely to be prosecuted (Gillan and Panasian 2015). This stems from companies manipulating earnings after paying higher premiums, which may cause a moral hazard (Boyer and Tennyson 2015). A review of corporate governance and managers' behavior before purchasing D&O insurance helps managers restrain their behavior (Core 2000). Consequently, this can partially curb managers' inappropriate disclosure. Conversely, post-purchase management actions may give rise to moral hazard issues and opportunistic behavior, adversely affecting shareholder interests and enterprises' long-term growth (Chung and Wynn 2008). Management may conceal and distort environmental information disclosure to maximize personal interests. Few studies have been conducted in developing countries. Ample evidence supports the claim that D&O insurance plays a crucial role in firms' decision-making and environmental protection efforts. Hence, understanding the relationship

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between D&O insurance and firms' environmental disclosure is fundamentally important to scholars, managers, and regulators.

The data used in this study were derived from the China Research Data Service Platform (CNRDS), focusing on environmental information disclosure by heavily polluting Chinese enterprises from 2010 to 2017, and their records of purchasing D&O insurance. Through empirical testing, we confirm that companies significantly contributing to pollution can improve the quality of their environmental information disclosure by continuing to purchase D&O insurance.

D&O insurance purchase and corporate environmental information disclosure may be determined endogenously. Hence, this study introduces propensity score matching with the difference-in-differences (DID) method to eliminate potential endogenous problems. Additionally, a fixed effects model was used to eliminate the influence of factors that could not be observed over time.

To ensure the accuracy of the regression analysis, we successively replaced explanatory variables and expanded our sample size to verify the stability of our conclusions. Quantile regression was performed to exclude the effect of extreme values. Throughout this process, we controlled for city and provincial influences, as well as other potential personality traits of executives.

Furthermore, we delved deeper into the heterogeneity of our primary results. Particularly, our study revealed that state-owned enterprises and firms without environmental penalties, financial restatements, or audits by the top 10 accounting firms positively impact the quality of corporate environmental information disclosure after purchasing executive liability insurance. Additionally, D&O insurance enhances the quality of information disclosure by enhancing transparency and analyst tracking through an intermediary effect model.

Our study contributes to the existing literature in three ways. First, it extends the existing research on D&O insurance beyond previous focuses, such as corporate mergers and acquisitions (Lin et al. 2011), stock price crashes (Yuan, Sun, and Cao 2016), investment efficiency (Li and Liao 2014), debt costs (Lin et al. 2013), tax avoidance (Zeng 2014), earnings management (Boyer and Tennyson 2015), litigation risk (Gillan and Panasian 2015), innovation (Wang, Zhang, Huang and Zhang 2020), and corporate value (Hwang and Kim 2018). This study specifically examines the impact of D&O insurance on the quality of environmental information disclosure. Our findings affirmatively demonstrate that D&O insurance has a positive effect on environmental information disclosure quality. Moreover, we offer a fresh perspective by extending previous research.

Second, we investigated the factors influencing corporate environmental information disclosure. These factors include corporate performance, investor returns, and debt financing, among others, as identified in previous studies (Griffin, Lont, and Sun 2017; Jung, Herbohn, and Clarkson 2018; Meng, Zeng, and Tam 2013). Our study reveals the significant impact of D&O insurance on the quality of corporate environmental information disclosure, offering valuable insights for policymakers and regulators in the environmental protection sector (Wang, Zhang, and Zhang 2019; Zhang, Shao, and Fan 2020).

Third, this study investigates the correlation between D&O insurance and the disclosure of environmental information. It also enhances the understanding of the contribution of D&O insurance to corporate governance in the context of environmental information disclosure. This study explores the mechanisms by which D&O insurance influences governance, such as by integrating information transparency and analyst tracking into the research framework. By analyzing the internal governance impacts of implementing D&O insurance, this study offers new perspectives on governance theory.

The remainder of this paper is organized as follows. Section 2 presents the hypotheses. Section 3 introduces the study design, including the data, variables, and model settings. Section 4 discusses the regression results and conducts further analysis. Section 5 explores the underlying mechanisms and Section 6 concludes the study.

2. Hypotheses Development

Disclosure may reduce information asymmetry. However, managers may still be motivated to manipulate information after weighing the costs and benefits of managing accounting

information, particularly when accounting regulations and audits are insufficient (Healy and Palepu 2001). Environmental information plays a crucial role in corporate social responsibility (CSR) (Kuo, Yeh, and Yu 2012). Companies' disclosure of environmental information allows insurance companies to assess the management's approach to social responsibility, shedding light on potential motivations for opportunism and moral hazards. Consequently, the motivation for voluntary disclosure has received considerable attention in academic and environmental circles.

The decisions made by enterprise management significantly influence enterprise behavior. Therefore, environmental values and knowledge of enterprise management impact the environmental behavior of enterprises. We believe that internal influence is crucial to the disclosure of corporate environmental information. Managers not only play an essential role in internal influence but are also primarily responsible for disclosing such information. Additionally, managers have dual attributes that affect the information disclosure environment. On one hand, they may face pressure from institutional investors and environmental organizations to voluntarily disclose environmental information to mitigate specific environmental risks (Haque and Ntim 2018). On the other hand, executives' expectations regarding salary and career advancement incentivize them to strategically manage the extent of environmental disclosure. Consequently, these two motives for environmental disclosure give rise to two opposing views on the quality of disclosure facilitated by D&O insurance.

From a stress perspective, D&O insurance can play a more active role in corporate environmental disclosure. On one hand, insurance companies implement various measures to monitor insured companies and increase the company's environmental information disclosure. For example, in issuing insurance policies, insurance companies scrutinize the past behavior of insured companies. They establish insurance conditions for directors and senior managers to monitor their behavior and further regulate executive behavior regarding selective disclosure. Thus, insurance companies may insure companies with good information disclosure behavior. However, for companies with poor information disclosure practices, insurance companies may need to charge higher premiums to prevent additional losses caused by the company's misconduct. On the other hand, D&O insurance raises the costs associated with disclosing environmental information in violation of the law. Specifically, it increases the company's premium and litigation pressure (Boyer and Stern 2012; Hwang and Kim 2018), which, in turn, prevents improper environmental information disclosure by senior executives. According to Core (2000), the premium amount reflects the quality of corporate governance. This is evidenced by higher premiums charged by D&O insurance when corporate governance declines (Boyer and Stern 2012). Consequently, companies purchasing D&O insurance exhibit better environmental information disclosure practices.

From the indulgence hypothesis perspective, D&O insurance may create excessive protection for management, leading to reduced legal costs, a diminished sense of duty, and increased opportunistic motivation. Insurance can lower management lawsuit expenses for manipulating company information, potentially incentivizing them to conceal accurate environmental data and deceive shareholders. Conversely, an increase in corporate governance risk due to D&O insurance could reduce accounting information efficiency and provide more opportunities for management to exploit inaccurate information. In summary, we offer two competing assumptions regarding the impact of D&O insurance on environmental information disclosure.

H1a (Supervision Hypothesis): Under similar conditions, firms that purchase D&O insurance can improve the quality of their environmental information disclosure.

H1b (Indulgence Hypothesis): Under similar conditions, firms that purchase D&O insurance will reduce the quality of their environmental information disclosure.

3. Research Design

3.1. Sample Selection

Our primary data sources are the China Research Data Service Platform (CNRDS) and China Stock Market Accounting Research (CSMAR) databases. Specifically, D&O insurance and environmental information disclosure quality data were obtained from the CNRDS, while financial data were sourced from CSMAR. We specifically focused on listed Chinese companies that significantly contribute to pollution. According to the "Guidelines for Environmental Information Disclosure of Listed Companies" (Draft for Comment) published by the Ministry of Ecology and Environment of the People's Republic of China in 2010, we define heavily polluting firms as those operating in thermal power, steel, cement, electrolytic aluminum, and 16 other industries. Heavily polluting firms should regularly disclose detailed environmental information regarding pollutant discharge, environmental compliance, and management in their environmental reports. Consequently, our sample period spans from 2010 to 2017.

Two types of environmental information disclosure scores for the robustness test were obtained from the Rankins CSR Ratings database and the Public Environmental Research Center (IPE[2]). Finally, we obtained 747 listed firms and 4,436 annual company observations.

3.2. Model Specifications

To test the impact of D&O insurance on the quality of companies' environmental information disclosure, we establish the following regression model.

$$EID_{i,t} = b_0 + b_1 D\&O + Controls + Year\ FE + Industry\ FE + e_{i,t} \quad (1)$$

where *i* and *t* represent company and year, respectively. *EID* denotes the explained variable indicating the quality of a company's environmental information disclosure in year *t*. *D&O* signifies the explanatory variable indicating that company *i* purchases D&O insurance in *t* years (including D&O and D&O*year*). The coefficient symbol and numerical value before *D&O* can be used to identify the influence of environmental safety on D&O information disclosure quality. ***Controls*** include *lev, size, age, Dual, board, growth, ROA, Indep, Mshare, firsthold, Inst, Year dummy*, and *industry dummy*. $e_{i,t}$ is the random error term. Detailed definitions of the main variables are provided in the Appendix.

3.3. Variable Definitions

3.3.1. Definitions of the Main Variables

Given that environmental information involves various dimensions (Cormier, Magnan, and Van Velthoven 2005), we characterize the quality of environmental information disclosure using eight dimensions and the sum of the eight indicators. The eight dimensions are as follows.

(1) Environmentally beneficial product: Companies are assigned a value of one if it develops or uses an innovative product, device, or technology that benefits the environment; otherwise, they are assigned a value of zero.
(2) Measures implemented to reduce three types of waste: companies that have adopted policies, measures, or technologies to reduce the emissions of waste gases, water, residue, and greenhouse gases are assigned a value of one; otherwise, they are assigned a value of zero.
(3) Circular economy: Companies that use renewable energy or adopt circular economy-related policies and measures are assigned a value of one; otherwise, they are assigned a value of zero.

(4) Energy saving: Companies that have implemented policies, measures, or technologies to save energy are assigned a value of one; otherwise, they are assigned a value of zero.
(5) Green office: Companies that have implemented green office policies or measures are assigned a value of one; otherwise, they are assigned a value of zero.
(6) Environmental certification: Companies that are ISO 14,001 certified are assigned a value of one; otherwise, they are assigned a value of zero.
(7) Environmental recognition: Companies that have received environmental recognition or other positive evaluations are assigned a value of one; otherwise, they are assigned a value of zero.
(8) Other advantages: Companies with additional environmental advantages not listed in the above indicators are assigned a value of one; otherwise, they are assigned a value of zero.

The variable D&O is a dummy variable. A value of one indicates that the company's board of directors has decided to purchase D&O insurance and that this decision has been approved at the general meeting of shareholders. A value of zero indicates all other situations. If a listed company decides to purchase D&O insurance without terminating, it is assumed that it will continue purchasing the insurance. *D&Oyear* represents the number of years the company has purchased D&O insurance, calculated by taking the natural logarithm of the sum of the number of years plus one.

3.4. Control Variables

We used factors that have influenced environmental information disclosure in previous studies as control variables. We use total debt divided by total assets to represent the leverage ratio denoted by *lev*. According to Zeng et al. (2012), we controlled for the age of a company, computed based on the IPO year. We use the natural logarithm of total assets as a proxy variable for firm size, denoted by *size*. Additionally, we set a dummy variable, duality (*dual*). When the general manager and chairman of the board of directors are the same in year t, *dual* takes a value of one; otherwise, it is 0. Board size (*Board*) is equally defined as the natural logarithm of the number of directors. The growth rate (*growth*) is equal to the increased percentage of sales growth (Baldini et al. 2018). Return on assets (*ROA*) is the ratio of net income to total assets. *Indep* is the proportion of independent directors on a board. Mallin, Michelon, and Raggi (2013) found that shares held by different types of investors are related to environmental information disclosure. Thus, we controlled for three types of shareholdings. *Mshare* and *firsthold* represent the shareholding ratios of senior management and the largest shareholder, respectively. Institutional shareholdings (*Inst*) is the proportion of institutional investor holdings. The definitions of the other variables are in the Appendix.

3.5. Descriptive Statistics

To eliminate the impact of outliers, we winsorized all continuous variables at 1%. Table 1 shows the descriptive statistics for all variables. The average value of environmental information quality is 0.9004, indicating poor environmental information disclosure quality in listed companies. The proportion of D&O insurance purchased is 5.79% and the average purchase duration is 0.12 years,[3] reflecting the relatively low percentage of listed companies purchasing D&O insurance and a short holding period. The descriptive statistics for the other variables are within the normal range.

Table 2 shows the distribution of all polluting firms that purchased D&O insurance for senior management from 2010 to 2017. Table 2 (panel A) shows that the number of listed companies purchasing executive liability insurance in China is increasing annually. The results in the first row of Panel B show that the quality of environmental information disclosure (*EID*) of companies that have acquired D&O insurance is significantly higher than that of companies that did not, indicating that the purchase of D&O insurance promotes corporate environmental information disclosure.

Table 1. Summary statistics.

Variable Name	Obs	Mean	SD	Min	Median	Max
EID	4436	0.9004	1.6331	0.0000	0.0000	8.0000
D&O	4436	0.0579	0.2336	0.0000	0.0000	1.0000
D&Oyear	4436	0.1103	0.4649	0.0000	0.0000	2.4849
Lev	4436	0.4133	0.2138	0.0447	0.4029	0.9411
size	4436	22.1118	1.2276	19.7736	21.9283	25.9096
age	4436	2.1468	0.7481	0.0000	2.3026	3.1781
Dual	4436	0.2464	0.4310	0.0000	0.0000	1.0000
Board	4436	2.1569	0.1940	1.6094	2.1972	2.7081
growth	4436	0.1796	0.3938	0.4662	0.1181	2.6359
ROA	4436	0.0409	0.0593	0.1805	0.0372	0.2100
Indep	4436	0.3716	0.0817	0.0000	0.3636	0.6000
Mshare	4436	0.1148	0.1919	0.0000	0.0006	0.6796
firsthold	4436	0.3565	0.1511	0.0841	0.3382	0.7889
Inst	4436	0.3977	0.2317	0.0030	0.4057	0.9059

Note: This table reports descriptive statistics on EID, D&O insurance, and control variables for the sample in 2010–2017. All variables are defined in Appendix.

Table 2. Sample distribution and differences.

year		*D&O* = 0		*D&O* = 1	The Total
Panel A: Sample distribution					
2010		340		21	361
2011		448		26	474
2012		521		31	552
2013		532		33	565
2014		527		29	556
2015		555		36	591
2016		600		36	636
2017		656		45	701
The Total		4179		257	4436
Variable	Obs.	Scheme (*D&O* = 0)	Obs.	Scheme (*D&O* = 1)	Mean—the diff
Panel B: Sample difference					
EID	4179	0.818	257	2.233	1.415***
Lev	4179	0.410	257	0.474	0.065***
size	4179	22.042	257	23.245	1.203***
age	4179	2.116	257	2.643	0.527***
Dual	4179	0.251	257	0.163	0.088 * *
Board	4179	2.154	257	2.206	0.053***
growth	4179	0.180	257	0.175	0.005
ROA	4179	0.041	257	0.034	0.007
Indep	4179	0.373	257	0.341	0.032***
Mshare	4179	0.121	257	0.007	0.114***
firsthold	4179	0.354	257	0.405	0.051***
Inst	4179	0.390	257	0.526	0.137***

Note: Univariate analysis. Panel A presents the firm purchases D&O insurance in different years. Panel B compares the mean differences of the variables between D&O insured firms and no insured firms. *** indicates that the statistic is significantly different from zero at the 0.01 level using a two-tailed t-test.

4. Regression Results

4.1. Baseline Results

Table 3 shows how D&O insurance affects the quality of companies' environmental information disclosure. The results of the regression coefficients significantly support H1a. In Columns (1) and (2) of Table 3, the coefficients of *D&O* and *D&Oyear* are 0.6390 and 0.3012, respectively, which are both positive and significant at the 5% level. This finding suggests that purchasing D&O insurance significantly affects the quality of corporate environmental information disclosure. This result strongly supports our supervisory hypothesis. Specifically, the supervisory roles of insurance companies in

Table 3. Baseline results.

	(1)	(2)
D&O	0.6390**	
	(2.55)	
D&Oyear		0.3012**
		(2.39)
Lev	0.7697***	0.7873***
	(3.36)	(3.43)
Size	0.5905***	0.5951***
	(11.87)	(11.97)
Age	0.1210*	0.1218*
	(1.79)	(1.79)
Dual	0.0249	0.0219
	(0.28)	(0.25)
Board,	0.5586**	0.5639**
	(2.15)	(2.16)
Growth	0.2282***	0.2269***
	(4.35)	(4.31)
ROA	0.8776	0.8765
	(1.43)	(1.43)
Indep	0.0681	0.1072
	(0.18)	(0.28)
Mshare	0.2672	0.2644
	(1.02)	(1.01)
Firsthold	0.0381	0.0494
	(0.11)	(0.14)
Inst	0.5896***	0.5901***
	(3.42)	(3.42)
Constant	13.6912***	13.7838***
	(10.64)	(10.70)
Industry Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
N	4436	4436
Adj. R2	0.263	0.262

Note: This table shows the results from the OLS regression of the impact of D&O insurance on EID. T-statistics in the brackets are based on standard errors adjusted for clustering at the firm level. ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels (two-tailed), respectively.

purchasing D&O insurance information disclosure prevent companies from accumulating adverse news. This oversight leads to a positive external corporate governance effect, thereby improving information disclosure quality regarding the corporate environment.

4.2. Endogeneity

4.2.1. Propensity Score Matching and Difference in Differences (PSM-DID) Analysis

This section verifies the main assumptions of this study using the PSM-DID model. The first step involves PSM, which identifies the year before the company's initial purchase of liability insurance. A Probit model is used to score the propensity of sample enterprises to purchase liability insurance, followed by one-to-one nearest neighbor matching to pair enterprises that have not purchased liability insurance across all years, resulting in a sample of 514 companies handling D&O insurance. The second step involves the DID method. The experimental group company obtained after PSM treatment is denoted by *Treat* and equals to one. The control company obtained after PSM treatment is represented by *Treat* and equals to zero. Simultaneously, the time dummy variable *POST* is set. When a company purchases D&O insurance, *POST* is one; otherwise, it is zero. This section focuses on the coefficient of the interaction term *Treat*×*POST*, which measures the change in the quality of environmental information disclosure before and after a company purchases D&O insurance. As shown in

Column (1) of Table 4, the coefficient of *Treat×POST* is positive and significant. This shows that the quality of environmental information disclosure by companies that purchase D&O insurance significantly improves compared to companies that do not, thus proving the robustness of our conclusions.

4.2.2. Fixed Effects Model

We used a fixed effects model to eliminate potential endogenous problems caused by unobservable factors that did not change over time (Yuan, Sun, and Cao 2016), and re-estimated the model. The regression results are presented in Table 5. The main explanatory variables are significantly positive, at least at the 10% level. Thus, our regression controlled for both year and fixed effects to eliminate endogeneity.

4.3. Robustness Tests

4.3.1. Model Re-Estimation Using Quantile Regression

Least-squares regression is susceptible to extreme values. Therefore, we applied quantile regression, which minimizes the weighted average of the absolute value of the residuals, to exclude the effects of extreme values. Panel A of Table 6 shows that the coefficients for D&O are positive at the 75% and 90% quantiles, which are significant at the 5% level. Additionally, the coefficient for D&O*year* in the 75%

Table 4. PSM-DID regression results.

	(1)
Treat×POST	0.7250***
	(3.30)
Lev	−1.6956***
	(−3.55)
Size	0.7129***
	(9.99)
Age	0.5040**
	(2.22)
Dual	−0.0883
	(−0.39)
Board	1.4976***
	(3.37)
Gowth	−0.4533***
	(−2.71)
ROA	0.0589
	(0.04)
Indep	0.0802
	(0.14)
Mshare	3.2929
	(1.22)
Firsthold	0.6634
	(0.99)
Inst	1.4842***
	(3.50)
Constant	−18.9011***
	(−10.43)
Industry Fixed Effect	Yes
Year Fixed Effect	Yes
N	514
adj. R^2	0.436

Note: This table reports the regression results of PSM-DID, Since the year is in line with Post, no post is added to the equation. t statistics in parentheses, ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels (two-tailed), respectively.

Table 5. Fixed effects model results.

	(1)	(2)
D&O	0.5401**	
	(2.00)	
D&Oyear		0.3520*
		(1.91)
Lev	−0.1461	−0.1760
	(−0.89)	(−1.08)
Size	0.1945***	0.1923***
	(4.02)	(3.96)
Age	0.1207	0.1347
	(1.35)	(1.52)
Dual	−0.0439	−0.0417
	(−0.78)	(−0.73)
Board	0.0463	0.0502
	(0.30)	(0.33)
Growth	−0.0544*	−0.0523*
	(−1.73)	(−1.66)
ROA	0.1372	0.1121
	(0.35)	(0.28)
Indep	0.1846	0.1598
	(0.77)	(0.69)
Mshare	0.2607	0.2531
	(1.10)	(1.06)
Firsthold	−0.0116	0.0122
	(−0.04)	(0.04)
Inst	−0.1325	−0.1473
	(−1.17)	(−1.31)
Constant	−3.7201***	−3.6838***
	(−3.58)	(−3.54)
Firm Fixed Effect	Yes	Yes
Year Fixed Effect	Yes	Yes
N	4436	4436
Adj. R^2	0.018	0.018

Note: This table shows the results of fixed effect model. T-statistics in the brackets are based on standard errors adjusted for clustering at the firm level. ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels (two-tailed), respectively.

and 90% quantiles are significantly positive. Hence, our results remain significant even after excluding the effects of extreme values.

4.3.2. Inclusion of Control Variables

We believe that the characteristic status of provinces and cities (e.g., local environmental policies) affects corporate environmental information disclosure. Therefore, dummy variables for cities and provinces were included in the regression to control for their impact on corporate environmental information disclosure. As Columns (1) and (2) of Panel B in Table 6 show, the coefficients of *D&O* and *D&Oyear* are significantly positive at the 5% level. The regression results indicate that our main results remain significant even after controlling for provincial and urban factors.

Following Jia, Mao, and Yuan (2019), our model incorporated variables for penalties against senior executives and the general manager's affiliation with the CPPCC or participation as a delegate in the National People's Congress. Columns (3) and (4) of the panel of Table 6C show the results. The main explanatory variables are significantly positive, at least at the 5% level. This further proves the stability of our results.

4.3.3. Substituting the Explained Variable

First, we replaced the quality score of environmental disclosure with the social responsibility score of listed firms in the Runling Global Responsibility Rating. The results show that enterprises actively fulfill their social responsibilities. Second, we replaced the quality scores of environmental information

Table 6. Robustness tests.

	(1) 75% quantile	(2) 90% quantile	(3) 75% quantile	(4) 90% quantile
Panel A: quantile regression				
D&O	0.6596***	0.5756**		
	(3.13)	(2.13)		
D&Oyear			0.3050***	0.2401*
			(2.84)	(1.76)
Constant	−17.4881***	−22.1389***	−17.5995***	−22.5415***
	(−13.53)	(−13.37)	(−13.41)	(−13.52)
Control variables	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
N	4436	4436	4436	4436
pseudo R^2	0.2572	0.2289	0.2565	0.2281
Panel B: adding control variables				
D&O	0.6438**		0.6454***	
	(2.46)		(2.58)	
D&Oyear		0.2919**		0.3038**
		(2.21)		(2.42)
Punish			0.1035	0.1065
			(1.15)	(1.18)
CPPCC			0.2138	0.2109
			(1.63)	(1.61)
Constant	−13.5342***	−13.6378***	−13.7980***	−13.8928***
	(−8.12)	(−8.22)	(−10.75)	(−10.81)
Control variables	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
City Fixed Effect	Yes	Yes	No	No
Province Fixed Effect	Yes	Yes	No	No
N	4436	4436	4436	4436
adj. R^2	0.414	0.412	0.265	0.264
	Runling ratings scores		IPE score	
	(1)	(2)	(3)	(4)
Panel C: replacing the explained variables				
D&O	4.6095**		5.1373**	
	(2.22)		(2.16)	
D&Oyear		2.0736**		2.4081*
		(1.99)		(1.95)
Constant	−53.4236***	−54.9492***	51.3785***	50.6607***
	(−3.19)	(−3.20)	(3.66)	(3.61)
Control variables	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
N	1244	1244	2758	2758
adj. R^2	0.435	0.432	0.449	0.449
	(1)		(2)	
Panel D: Enlarge sample				
D&O	0.6747***			
	(5.32)			
D&Oyear			0.3419***	
			(5.07)	
Constant	−12.6354***		−12.6899***	
	(−19.24)		(−19.23)	
Control variables	Yes		Yes	
Industry Fixed Effect	Yes		Yes	
Year Fixed Effect	Yes		Yes	
N	17869		17869	
adj. R^2	0.274		0.274	

Note: This table shows the results of robustness tests. In Panel A, the table shows the results of quantile regression. In Panel B, Columns 1 and 2 control City Fixed Effect and Province Fixed Effect. Columns 3 and 4 contain Punish and CPPCC. In Panel C, Columns 1 and 2 use Ruling ratings scores to replace of explained variables. Columns 3 and 4 use IPE score to replace of explained variables. In Panel D, the table shows enlarged sample.T-statistics in the brackets are based on standard errors adjusted for clustering at the firm level. ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels (two-tailed), respectively.

disclosure from the Public Environmental Research Center's (IPE) Pollution Source Regulatory Information Disclosure Index (PITI) for 113 cities nationwide and obtained the same results as above (see Panel D of Table 6 for details).[4] These results prove the stability of our conclusions.

4.3.4. Sample Size Expansion

To avoid bias caused by a small sample in the regression analysis, we used a larger sample size to verify the robustness of our conclusions. First, we expanded our research sample to encompass all companies purchasing D&O insurance listed on the SHSE and SZSE. Second, most listed firms engage in green office practices and hold environmental certifications. Therefore, employing a larger sample size is important. Panel E of Table 6 presents the results. The coefficients for D&O and D&O*year* in Columns (1) and (2) of Table 6 are significantly positive, confirming the robustness of the conclusions.

4.4. Heterogeneous Analysis

4.4.1. Firm Ownership

State-owned and non-state-owned enterprises coexist, with resource allocation still predominantly governed by the policies of central and local governments. This represents a unique aspect of China's economic marketization process. The property rights of non-state-owned enterprises, such as regulatory agencies and law enforcement protection, are not well received by formal institutions. In contrast, private enterprises are particularly disadvantaged in terms of access to resources (Chen et al. 2011). When the government has an incentive to protect state-owned enterprises, the probability of being sued is low. Purchasing D&O insurance allows corporate managers to evade legal liability, and firms may receive extra compensation from lawsuits to compensate potential rent seekers. Therefore, according to the nature of the enterprise, we classified listed companies into state-owned and non-state-owned enterprises, denoted as *soe* and *no-soe*, respectively. Table 7 presents the results. The coefficients for D&O and D&O*year* of state-owned enterprises are significantly positive, indicating that purchasing executive liability insurance by state-owned enterprises can strengthen environmental information disclosure.

4.4.2. Prior Penalization of Firms by Regulators

From the perspective of an insurance company, the risk of moral hazard increases when a company has been penalized. Increasing the premiums for insured companies can prevent potential adverse selection. Therefore, penalized firms will inevitably face higher premiums when purchasing D&O insurance. This significant expense may lead to a reluctance in maintaining insurance coverage. Non-penalized firms face pressure from insurance companies to raise premiums, which reduces violations. Based on the above analysis, we divided the sample into penalized and non-penalized companies. Table 8 presents the results. The coefficients for D&O and D&O*year* for non-penalized companies are significantly positive, indicating that the purchase of D&O insurance by non-penalized companies enhances the quality of the company's environmental information disclosure.

4.4.3. Firms' Restatement of Financial Reports

Financial restatement exacerbates the asymmetry of internal and external information, exposing operational and managerial deficiencies and signaling executives' self-interested motives. This can impact stakeholders, such as insurance companies. Insurance companies may restrict the disclosure of low-quality environmental information by charging higher premiums and imposing stricter insurance terms for listed companies with financial restatements. To receive favorable evaluations from insurance companies and lower premiums, executives are inclined to restrain their behavior and reduce low-quality disclosures.

Therefore, we divided the sample into companies that have restated their financial statements and those that have not. Table 9 presents the results. The coefficients for D&O and D&O*year* of companies that have not restated financial statements are significantly positive, indicating that the purchase of

Table 7. The effects of ownership.

	(1) soe	(2) Non—soe	(3) soe	(4) Non—soe
D&O	0.7916***	0.1083		
	(2.77)	(0.32)		
D&Oyear			0.3816***	0.0178
			(2.65)	(0.12)
Constant	16.8019***	10.4811***	16.9708***	10.4840***
	(9.41)	(5.18)	(9.53)	(5.16)
Control variables	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
Prob > chi2	0.0023		0.0001	
N	1703	2733	1703	2733
Adj. R^2	0.370	0.124	0.370	0.124

Note: The table shows the impact of purchasing D&O insurance on EID disclosures for SOEs and non-SOEs. T-statistics in the brackets are based on standard errors adjusted for clustering at the firm level. ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels (two-tailed), respectively.

D&O insurance by companies that have not restated financial statements enhance the quality of their corporate environmental information disclosure.

4.4.4. Audit Quality

To mitigate risks, insurance companies conduct thorough investigations into the operations, finances, corporate governance, and information disclosure of insured companies when entering into D&O insurance contracts. This scrutiny serves as a form of supervision. Consequently, the procurement of D&O insurance allows insurance companies to complement numerous corporate governance mechanisms, thereby aiding in the regulation of managerial conduct. Moreover, the purchase of such insurance subjects a company's activities and information to the oversight of insurance companies, acting as a potential substitute for other corporate governance mechanisms, including high-quality audit services. Consequently, D&O insurance serves as a replacement for auditing in companies without high-quality audits, thus fulfilling the supervisory responsibilities of an audit firm.

Therefore, we divided the sample based on whether companies were audited by the top ten accounting firms,[5] denoted by *big10* and *No-big10*. Table 10 presents the results. The coefficients for D&O and D&O*year* of *No-big10* are both significantly positive. This indicates that the purchase of D&O insurance by companies that have not been audited by the top 10 accounting firms will improve the quality of the company's environmental disclosure.

5. Mechanism Analysis

5.1. Effect of D&O Insurance on Firm Information Transparency

Corporate information transparency can impact corporate information disclosure behavior. When an enterprise has low information transparency, it becomes easier for managers to conceal poor environmental information. However, it also increases the likelihood of triggering regulatory penalties, such as receiving an inquiry letter from a stock exchange or even facing suspension owing to information disclosure violations, leading to investor lawsuits. Li and Xu (2020) concluded that D&O insurance plays a positive external governance role in restraining corporate violations. Therefore, the supervisory effect of D&O insurance enables the management to enhance corporate information transparency, thereby improving the quality of environmental information disclosure.

Therefore, we used a mediation effect regression analysis to provide a more intuitive explanation of how companies improve information transparency by purchasing D&O insurance, thereby

improving the quality of corporate environmental information disclosure. Columns (1) and (3) of Table 11 show that purchasing executive liability insurance increases the transparency of corporate information. As SYN[6] is a negative indicator, a higher value indicates less company-specific information contained in the stock price and lower transparency of corporate information. The results in Columns (2) and (4) show that after companies improve their information transparency, the SYN coefficient is significantly positive at the 1% level, indicating an intermediate effect. The corresponding D&O and D&O*year* coefficients are 0.6902 and 0.3278, respectively, which is significant at the 1% level. Thus, corporate information transparency plays an intermediary role in environmental information disclosure.

5.2. Effect of D&O Insurance on Analyst Tracking

Based on the moral hazard hypothesis, purchasing D&O insurance can transfer the risk of managers being sued and mitigates the professional risks faced by independent directors. This weakens the deterrent effect of the law and the supervisory role of independent directors, thereby intensifying agency conflicts and influencing resource allocation decisions. Therefore, more principal-agent problems may become evident. The professional analyst team mines the enterprise's internal information, reduces the asymmetry between internal and external information, and actively participates in corporate governance. Therefore, based on the moral hazard hypothesis, executive liability insurance leads to increased analyst tracking, which, in turn, reduces information asymmetry and improves information disclosure quality.

Therefore, we used a mediation regression to analyze how companies improve the quality of their environmental disclosures by increasing analyst tracking. Columns (1) and (3) of Table 12 show that purchasing executive liability insurance increases analyst tracking. The results in Columns (2) and (4) show that as the number of analysts increases, the coefficient for *Analyst* is significantly positive at the 10% level, indicating an intermediate effect. The corresponding *D&O* and *D&Oyear* coefficients are 0.6306 and 0.2964, respectively, which is significant at the 5% significance level. Therefore, analyst tracking plays a crucial mediating role in environmental information disclosure.

6. Conclusions

We examined the influence of D&O insurance on the quality of environmental information disclosure using exclusive data from China. After adjusting for various factors, our findings suggest that the procurement of D&O insurance positively affects the disclosure of

Table 8. The effects of environmental penalties.

	(1) punish	(2) No-punish	(3) punish	(4) No-punish
D&O	0.1698	0.6587***		
	(0.09)	(2.60)		
D&Oyear			0.1138	0.3094**
			(0.15)	(2.42)
Constant	1.9117	−13.4197***	2.4375	−13.5191***
	(0.15)	(−10.32)	(0.19)	(−10.38)
Control variables	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
Prob > chi2	0.0000		0.0000	
N	30	4406	30	4406
adj. R^2	−0.035	0.256	−0.032	0.255

Note: The table shows the impact of purchasing D&O insurance on EID disclosures for firms that have received environmental penalties. T-statistics in the brackets are based on standard errors adjusted for clustering at the firm level. ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels (two-tailed), respectively.

Table 9. The effects of restating financial reports.

	(1) restate	(2) No-restate	(3) restate	(4) No-restate
D&O	0.7860	0.6224**		
	(1.59)	(2.51)		
D&Oyear			0.2812	0.2998**
			(1.18)	(2.46)
Constant	−13.9428***	−13.6772***	−14.2379***	−13.7498***
	(−6.05)	(−10.52)	(−6.22)	(−10.56)
Control variables	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
Prob > chi2	0.0067		0.0097	
N	367	4069	367	4069
adj. R^2	0.264	0.266	0.258	0.265

Note: The table shows the impact of purchasing D&O insurance on EID disclosures for firms whether have financial restatements. T-statistics in the brackets are based on standard errors adjusted for clustering at the firm level. ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels (two-tailed), respectively.

Table 10. The effects of big 10 auditing firms.

	(1) big10	(2) No-big10	(3) big10	(4) No-big10
D&O	−0.3017	0.8474***		
	(−0.81)	(3.23)		
D&Oyear			−0.1447	0.3966***
			(−0.87)	(2.92)
Constant	−15.4846***	−12.9893***	−15.4733***	−13.1349***
	(−7.52)	(−9.72)	(−7.49)	(−9.81)
Control variables	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
Prob > chi2	0.0000		0.0000	
N	909	3527	909	3527
adj. R^2	0.286	0.263	0.286	0.262

Note: The table shows the impact of purchasing D&O insurance on EID disclosures for firms whether are audited by the Big10 accounting firms. T-statistics in the brackets are based on standard errors adjusted for clustering at the firm level. ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels (two-tailed), respectively.

environmental information. This impact is particularly significant in state-owned enterprises (SOEs) and companies that have not been subjected to environmental penalties, restatements, or audits conducted by the Big 10 accounting firms. Mechanism analysis indicates that the acquisition of D&O insurance enhances the transparency of corporate information and increases analyst attention, thereby contributing to the improvement of environmental information disclosure quality.

Overall, our research findings demonstrate the significant impact of D&O insurance on companies. These results unequivocally support the notion that D&O insurance plays a pivotal role in enhancing corporate governance regarding external information disclosure. Insurance companies actively monitor and oversee insured companies to mitigate potential compensation costs. Consequently, managers of publicly traded firms that opt for D&O insurance are less inclined to conceal unfavorable news, thereby augmenting their capacity to disclose information. This, in turn, increases the overall quality and transparency of environmental information.

Our study contributes to the literature on CSR disclosure and D&O insurance. Our study primarily investigates the impact of D&O insurance on enhancing the quality of environmental information disclosure, offering supportive evidence in favor of this perspective. Based on our findings, we recommend that Chinese regulators implement additional policies mandating the compulsory purchase of D&O insurance for executives of polluting companies.

Table 11. Mediating effect of information transparency.

	(1) SYN	(2) EID	(3) SYN	(4) EID
D&O	−0.0288*	0.6902***		
	(−1.90)	(2.80)		
D&Oyear			−0.0110*	0.3278***
			(−1.67)	(2.63)
SYN		0.5327***		0.5215***
		(3.39)		(3.31)
Constant	0.2740***	−13.9281***	0.2822***	−14.0229***
	(2.98)	(−10.68)	(3.07)	(−10.74)
Control variables	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
N	4319	4319	4319	4319
adj. R^2	0.282	0.269	0.282	0.268

Note: This table reports regression results of the likelihood of D&O insurance on a firm's EID and the moderating effect of the firm's SYN. T-statistics in the brackets are based on standard errors adjusted for clustering at the firm level. ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels (two-tailed), respectively.

Table 12. Mediating effect of analyst tracking.

	(1)	(2)	(3)	(4)
	Analyst	EID	Analyst	EID
D&O	0.0871*	0.6306**		
	(1.92)	(2.53)		
D&Oyear			0.0494**	0.2964**
			(2.17)	(2.36)
Analyst		0.0967*		0.0960*
		(1.80)		(1.79)
Constant	−0.1658	−13.6752***	−0.1657	−13.7679***
	(−0.59)	(−10.67)	(−0.59)	(−10.72)
Control variables	Yes	Yes	Yes	Yes
Industry Fixed Effect	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes
N	4436	4436	4436	4436
adj. R^2	0.039	0.264	0.039	0.263

Note: This table reports regression results of the likelihood of D&O insurance on a firm's EID and the moderating effect of the firm's Analyst. T-statistics in the brackets are based on standard errors adjusted for clustering at the firm level. ***, **, and * indicate significance at the 0.01, 0.05 and 0.1 levels (two-tailed), respectively.

Notes

1. D&O insurance enables senior executives to make decisive actions by protecting them from legal liability arising from their professional activities on behalf of the firm, which may shift in risk preferences and eventually affect firms' environmental disclosure. Additionally, insurance companies play an external monitoring role by thoroughly investigating the risks related to directors and senior management to reduce potential indemnity risks (Boyer and Stern 2012).
2. http://www.ipe.org.cn/.
3. Exp（0.1103）-1 ≈ 0.12.
4. In 2013, the number of cities that were included in the nationwide evaluation of the PITI expanded from 113 in 2009 to 120.
5. The Chinese Institute of Certified Public Accountants annually releases a comprehensive evaluation conducted by the top 100 accounting firms. We selected the evaluations of the top 10 accounting firms.
6. First, we used the capital asset pricing model (CAPM) to perform an annual regression on the weekly stock return data of each company to obtain the model fitting degree $R.^2$ Subsequently, we define $SYN=\log[R^2/(1-R^2)]$.

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Appendix. Variable Definitions

Variable	Definitions
EID	Environmental information disclosure quality is the total score of environmental products, measures taken to reduce three types of waste, circular economy, energy conservation, green office practices, environmental certification, environmental recognition, and other advantages.
D&O	A dummy variable equal to 1 if the company purchases D&O insurance, and 0 otherwise.
D&Oyear	The natural logarithm of the sum of the number of years the company has purchased D&O insurance, plus 1, in year t.
Lev	The ratio of the company's total debt divided by total assets in year t.
size	Enterprise size is equal to the natural logarithm of the company's total assets at the end of year t.
age	The age of the company is equal to the duration the company has been in the market.
Dual	A dummy variable that equals 1 if the CEO and chairman are the same person in year t, and 0 otherwise.
Board	The natural logarithm of the number of board directors in a board in year t.
growth	The increased percentage of sales growth in year t.
ROA	net profit divided by total assets in year t.
Indep	The proportion of independent directors on a board in year t.
Mshare	The proportion of shares held by senior executives in year t.
firsthold	The proportion of shares held by the largest shareholder in year t.
Inst	The proportion of shares held by institutional investors in year t.