



Directors' and officers' liability insurance and carbon emissions

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ARTICLE INFO

JEL classifications:

G22
G30
G34
M14
Q54
Q56

Keywords:

D&O insurance
Carbon emissions
Risk-taking

ABSTRACT

As climate-related issues become more serious, companies face mounting pressure to promote environmental governance. In this study, we examine companies' carbon emissions behavior from the perspective of corporate risk-taking. Analyzing China's company-level carbon emissions data from 2011 to 2021, we find that firms with directors' and officers' liability insurance (D&O insurance) have higher carbon emissions intensity. We then find that the D&O insurance-carbon emissions relationship exists among firms not involved in litigation in the previous year. Furthermore, this relationship becomes more pronounced when companies are under financial distress or have a higher number of analysts following them. Our results support the argument that companies with high risk-taking capacity exhibit greater polluting behavior.

1. Introduction

According to United Nations data, global greenhouse gas emissions are expected to increase by nearly 11 % between 2010 and 2030. Finding a habitable climate and achieving net zero emissions have become a global challenge. Given that enterprises emit carbon during production activities, examining the type of companies that account for more carbon emissions becomes crucial for environmental protection.

Research indicates that corporate governance mechanisms, such as the rights and responsibilities of key corporate governance actors (Aguilera et al., 2021), managerial incentives, and the market for corporate control, determine firms' environmental performance levels (Kock et al., 2011). Luo et al. (2021) found that corporate governance quality and managerial awareness of carbon risk significantly affect firms' carbon performance. These studies suggest that companies themselves can determine their emissions behavior. Companies incur costs to reduce carbon emissions, and carbon reduction strategies directly affect companies' production and profit; therefore, companies consider various factors when making environmental strategies. Directors' and officers' liability insurance (hereafter D&O insurance) might be a factor that companies consider when engaging in environmental behavior.

D&O insurance aims to reduce the managers' tendency to avoid risks and plays an important role in corporate governance (O'Sullivan, 1997). D&O insurance has the advantage over traditional methods, such as job promotion or salary incentive, of introducing third-party insurance companies to provide risk compensation and wealth support for managers' decision-making errors to improve their risk tolerance (Core, 2000). Meanwhile, studies have suggested that D&O insurance plays a supervisory role (Zhang et al., 2023). The insurance agency's premiums reflect a company's risk assessment (Cao et al., 2014). Companies with more fines for

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violations and noncompliance face higher insurance costs. Therefore, D&O insurance is an effective external monitoring mechanism. It can also encourage companies to disclose environmental information and reduce the information asymmetry between the company and the external environment (Yuan et al., 2016). Companies that purchase D&O insurance are highly scrutinized, thereby limiting their carbon emission behavior. The insurance can also decrease directors' and officers' personal legal liabilities (Chen et al., 2016), encouraging them to invest in environmental issues and innovation.

However, studies have found that an increase in enterprises' negative environmental behaviors increases the risk of a stock market crash and the likelihood of litigation risks and legal challenges (Kassinis and Vafeas, 2002; Safiullah et al., 2021). Directors and officers can transfer risks to insurance companies and realize risk transfer and hedging by purchasing insurance (Mayers and Smith, 1982; Core, 2000). Insurance offers protection from prosecution to company directors and officers, potentially stimulating their self-interested and opportunistic behaviors (Parsons, 2003; Lin et al., 2013). Consequently, they ignore the long-term benefits of environmental protection and become short-sighted when making decisions on carbon emissions reduction. Numerous studies on D&O insurance have determined its impact on securities litigation (Donelson et al., 2018), financial behaviors (e.g., Chung and Wynn, 2008; Chi and Weng, 2014; Lin et al., 2019), and economic consequences (e.g., Chung et al., 2015; Yuan et al., 2016; Chen et al., 2016). However, no studies have examined the relationship of carbon emissions between D&O insurance, a key corporate governance method.

Using data from Chinese A-share listed firms from 2011 to 2021, this study examines the difference in carbon emissions between companies that have purchased D&O insurance and those that have not. Our findings show that firms with D&O insurance emit more carbon. Companies with a high risk-taking capacity perform poorly in environmental governance decisions. The robustness test results are consistent with the conclusion. Furthermore, our research indicates that a relationship between D&O insurance and carbon emissions exists for firms that were not involved in litigation in the previous year. Moreover, such a relationship is considerably pronounced in companies experiencing high financial distress and attracting analysts' attention.

We make multiple contributions to the earlier work. First, our study introduces a fresh approach to improve corporate carbon emissions governance. Second, we contribute to the literature on the outcomes of D&O insurance purchases. Although many studies have focused on D&O insurance (e.g., Chung et al., 2015; Chen et al., 2016; Lin et al., 2019), few have explored the relationship between D&O insurance and environmental behavior. Zhang et al. (2023) found that enterprises with D&O insurance invested more in green innovation and patents but did not examine the relationship between D&O insurance and carbon emissions. While green investments reduce pollution treatment costs, they do not directly impact carbon emissions, which are the primary factor affecting the environment. From the social benefits perspective, we find the shortcomings of D&O insurance. Our study encourages insurance institutions to optimize their products to minimize corporate managers' optimistic and self-interested tendencies.

2. Hypothesis development

D&O insurance improves enterprises' external supervision (O'Sullivan, 1997). On the one hand, when companies purchase insurance, the insurance agency evaluates the company's risk (Core, 2000), helping to reduce information asymmetry. On the other hand, D&O insurance could expose firms to greater public scrutiny (Zhang et al., 2023) and higher financial costs of noncompliance. To avoid an increase in insurance premiums, companies must disclose more information on social responsibility (Yuan et al., 2016) and bind their violations after purchasing D&O insurance. According to the literature, firms with D&O insurance may experience stronger public supervision (Zhang et al., 2023) and significantly enhance their commitment to environmental responsibility.

D&O insurance also motivates corporate managers as it can cover legal expenses and potential lawsuit-related settlements (Chung and Wynn, 2008). This protection motivates directors and executives to behave their best, alleviates managers' risk-averse tendency, improves companies' risk-taking capacity and investment efficiency, and promotes green innovation and environmental protection investment (Zhang et al., 2023). Jaroenjitrkam et al. (2022) showed that in the context of reduced litigation risk, managers are relatively protected and are thus more willing to focus on corporate social responsibility (CSR).

Companies must actively assume responsibility for environmental governance to manage increased external scrutiny due to D&O insurance. Given the ability of insurance to transfer risks, companies may have more flexibility to invest in the environment. The insurance may also encourage managers to make bolder decisions in environmental protection and motivate them to increase their investment and risk tolerance in assuming social responsibility. Therefore, we propose hypothesis 1a.

H1a: Insured companies have lower carbon emissions than noninsured companies.

Studies have noted that negative environmental behaviors affect the stock price and abnormal returns (Gupta and Goldar, 2005; Flammer, 2013), implying that many stakeholders are concerned about the enterprises' environmental behavior. Freund et al. (2023) suggested that companies engage in CSR activities to reduce shareholder litigation risks in advance and alleviate subsequent repercussions. Liu (2018) found that companies' environmental social governance performance can improve firm reputation and reduce environmental litigation risks. Kassinis and Vafeas (2002) also found that companies' negative behaviors toward environment attract litigation risks and legal challenges. Companies buy D&O insurance to protect their directors and officers from financial liability if they are sued for decisions made on firm's behalf (Lin et al., 2013). Therefore, D&O insurance induces moral hazard by protecting directors and officers from shareholder lawsuits (Lin et al., 2011). D&O insurance also evokes managers' self-interested and opportunistic behaviors (Chalmers et al., 2002) and increases business risk (Lin et al., 2013). This appears to improve companies' risk-taking capacity and avoid making rational decisions on environmental governance.

As D&O insurance shields managers from environmental lawsuits, managers' opportunism could influence corporate

Table 1
Selection criteria of the samples.

Selection criteria	# of observations
Total firm-year observations available from 2011 to 2021	34,756
Samples deducted for the following reasons:	
observations under special treatment by stock exchanges (labeled ST, *ST, and PT)	(847)
Missing data of dependent variable	(8,597)
Missing data of independent variable	(1,562)
Missing data of control variables	(699)
Firm-year observations in final sample	23,051

Table 2
Definition of variables.

Variables	Definition
CE	Carbon emissions per year, in millions of tons
INSURED	<i>INSURED</i> =1 if a firm has purchased D&O insurance, otherwise, 0
LEV	Total debt divided by total assets
OCF	Cash from operating activities divided by total assets
CASH	Cash holdings divided by total assets
MV	The natural logarithm of the sum of market value of equity and book value of debt
GROW	Revenue growth rate
ROA	Net profit divided by total assets
AGE	Number of years of operating history
TANG	Total fixed assets divided by total assets
TOP1	Shareholding ratio of the largest shareholder
DUAL	<i>DUAL</i> =1 if a firm's chairperson and general manager are both the same person, otherwise, 0
SOE	<i>SOE</i> =1 if a firm is state-owned, otherwise, 0

Table 3
Descriptive statistics*.

Variable	Mean	Std.	Min	Median	Max
CE	0.357	0.902	0.005	0.086	6.465
INSURED	0.082	0.275	0.000	0.000	1.000
LEV	0.413	0.203	0.053	0.405	0.868
OCF	0.050	0.066	−0.139	0.049	0.234
CASH	0.158	0.122	0.012	0.122	0.611
MV	22.804	1.188	20.785	22.625	26.491
GROW	0.170	0.351	−0.481	0.115	2.100
ROA	0.042	0.055	−0.184	0.040	0.196
AGE	17.887	5.711	5.000	18.000	32.000
TANG	0.227	0.156	0.003	0.196	0.699
TOP1	35.122	14.760	9.000	33.340	74.980
DUAL	0.289	0.454	0.000	0.000	1.000
SOE	0.345	0.475	0.000	0.000	1.000

* This table shows the summary statistics of all variables for the sample of 23,051 firm-year observations from 2011 to 2021. All variables are defined in Table 2.

environmental governance decisions. Therefore, we propose hypothesis 1b.

H1b: Insured companies have higher carbon emissions than noninsured companies.

3. Research design and empirical results

3.1. Research design and descriptive statistics

We gather data on carbon emissions (e.g., emissions from combustion, production process emissions, waste emissions, and emissions from land converted from forest to industrial land) from annual and social responsibility reports, company websites, and environmental department websites. If firms disclose their annual direct, indirect, or total carbon emissions, we use the data provided in their reports and standardize the units. If carbon emissions are not directly disclosed, then we calculate carbon emissions based on types of energy, electricity, and heat consumption, according to the Accounting Methods and Reporting Guidelines for Enterprise Greenhouse Gas Emissions issued by the National Development and Reform Commission for different industries.

We used A-share listed companies in China from 2011 to 2021 as our research sample. Carbon emission data were derived from the

Table 4
Regression results for D&O insurance on carbon emissions*.

Variable	(1)	(2)	(3)
INSURED	0.089*** (5.50)	0.048** (2.37)	0.099*** (2.91)
LEV	-0.027 (-0.86)	0.845*** (21.72)	0.328*** (2.63)
OCF	-0.027 (-0.54)	0.215*** (3.43)	0.149 (0.46)
CASH	0.316*** (9.51)	0.187*** (4.48)	-0.117 (-0.58)
MV	0.210*** (31.34)	0.507*** (60.42)	0.809*** (48.35)
GROW	0.090*** (11.52)	0.388*** (39.54)	0.030 (0.58)
ROA	0.054 (0.77)	1.291*** (14.50)	-1.822*** (-4.66)
AGE	-0.028*** (-2.97)	-0.014 (-1.20)	-0.010*** (-2.79)
TANG	-0.002 (-0.06)	-0.025 (-0.52)	0.009 (0.07)
TOP1	0.003*** (6.58)	0.001** (2.44)	0.006*** (4.73)
DUAL	0.025*** (2.76)	0.022* (1.92)	0.172*** (3.62)
SOE	-0.100*** (-4.95)	-0.003 (-0.12)	-0.010 (-0.24)
Intercept	-4.057*** (-17.85)	-14.164*** (-49.69)	-18.522*** (-49.02)
YearFE	YES	YES	YES
FirmFE	YES	YES	NO
IndFE	NO	NO	YES
N	23051	22998	3388
adj. R2	0.845	0.906	0.556

* This table shows the regression results for D&O insurance on carbon emissions. In Columns (1) and (2), the dependent variables are carbon emissions of firms in millions of tons (CE) and natural logarithm of carbon emissions of firms (lnCE), respectively. Column (3) reports the results after PSM. When matching samples, dependent variable is INSURED, and other control variables are the same as regression (1). We use nearest-neighbor matching, without replacement, with a caliper of 0.03. Moreover, the treatment and control firms should be in the same industry and the same year. All control variables are defined in Table 2. All variables are winsorized at the 1st and 99th percentiles. *, **, and *** denote significance at the 10 %, 5 %, and 1 % level, respectively, and t statistics are in parentheses.

annual reports, social responsibility reports, company websites, and environmental department websites of firms. D&O insurance and other governance data are from the CSMAR database. Table 1 outlines the sample selection process, which results in a test sample of 23,051 firm-year observations.

We use the following model to determine the relationship between D&O insurance and carbon emissions:

$$CE_{it} = \alpha + \beta_1 INSURED_{it} + \gamma Controls_{it} + YearFE + FirmFE + \varepsilon_{it} \quad (1)$$

The dependent variable *CE* indicates carbon emission (in millions of tons). *Insured* is the independent variable. *INSURED* = 1 if a firm has purchased D&O insurance; otherwise, 0. Our regression includes a set of control variables for firm-specific characteristics. We also include year- and firm-fixed effects. We winsorize all continuous variables at the 1 % and 99 % levels. All variables are defined in Table 2.

Table 3 lists the descriptive statistics for variables used in our analysis. The mean carbon emissions of our sample firms is 0.357, while the median is 0.086, implying a right-skewed distribution. Consistent with existing studies, 1,897 firms in our observations have purchased D&O insurance, accounting for 8.2 % of the total samples.

3.2. The impact of D&O insurance on carbon emissions

Table 4, Column (1), shows the empirical results of the association between D&O insurance and corporate carbon emissions. The result shows that companies with D&O insurance have more carbon emissions. This supports H1b that D&O insurance has a risk-taking effect, making managers more short-sighted on environmental governance decisions; therefore, these companies engage in more carbon emissions.

Because *CE* has skewness, we use the natural logarithm of *CE* (*ln(CE)*) as a dependent variable for robustness check. Table 4, Column (2) shows the regression results and confirms H1b. We use propensity score matching (PSM) to address the issue of selection bias. As shown in Table 4, Column (3), the result verifies the robustness of H1b.

Table 5
Regression results using Kangmei fraud cases as instrumental variables^a.

	(1) INSURED	(2) CE
IV-2019	0.044*** (11.29)	
INSURED		0.461** (2.01)
LEV	−0.047*** (−4.05)	0.178*** (5.42)
OCF	0.064** (2.06)	−0.168** (−2.02)
CASH	0.015 (0.88)	0.396*** (9.06)
MV	0.059*** (32.43)	0.465*** (31.35)
GROW	−0.002 (−0.47)	0.010 (0.74)
ROA	−0.330*** (−8.10)	−0.579*** (−4.33)
AGE	0.002*** (5.05)	−0.011*** (−10.39)
TANG	−0.031** (−2.41)	−0.058* (−1.69)
TOP1	−0.000* (−1.94)	0.004*** (13.78)
DUAL	−0.006 (−1.54)	0.069*** (6.63)
SOE	0.059*** (13.60)	−0.016 (−0.97)
Intercept	−1.289*** (−32.70)	−10.352*** (−32.14)
N	23051	23051
adj. R2	0.103	0.442

^a This table shows the regression results with the Kangmei fraud case as the instrumental variable, which are estimated by the two-stage least squares method (2SLS). Columns (1) and (2) report the results of the first and second stage, respectively. All control variables are defined in Table 2. All variables are winsorized at the 1st and 99th percentiles. *, **, and *** denote significance at the 10 %, 5 %, and 1 % level, respectively, and t statistics are in parentheses.

To address potential endogeneity issues, this study used the Kangmei Pharmaceutical financial fraud case as an instrumental variable to verify the robustness. In 2019, Kangmei was fined 600,000 yuan by the China Securities Regulatory Commission for financial fraud, and 21 responsible individuals were fined between 100,000 and 900,000 yuan. The company's actual controllers and four former senior executives are 100 % jointly and severally liable for this compensation, while 13 more senior executives are partially liable, jointly and severally, based on the degree of their fault. The market was severely shaken by these substantial penalties. Therefore, to mitigate future governance risks, listed companies may decide to buy more D&O liability insurance. However, it is unlikely that a single instance of financial fraud would directly impact carbon emissions decisions on. Given that the initial legal judgment in this case was imposed in 2019, this study introduces an instrumental variable, IV-2019, which is assigned a value of 1 for 2019 and subsequent years, and 0 otherwise. Two-stage least squares (2SLS) estimation is used, and the regression results are presented in Table 5. The results remain consistent with the earlier conclusions.

4. Additional analyses

4.1. Impact of legal risks

H1b supports D&O insurance helps managers with litigation expenses and improve the company's risk-taking capacity. We further test the relationship between D&O insurance and carbon emissions for firms with legal risk. We check whether firms were sued in the past to measure the risk of being sued. If companies were sued in the past and their problems and risks were detected, the company is less likely to incur legal costs again.

Table 6, Columns (1) and (2), show the regression results of whether companies were sued and not sued, respectively, in the past. The positive relationship between D&O insurance and carbon emissions is significant only for firms not sued in the previous year, indicating that companies that purchase insurance can reduce concerns about litigation costs associated with carbon emissions and therefore have more carbon emissions.

Table 6
The impact of legal risks^a.

Variable	(1)	(2)
INSURED	−0.066 (−1.64)	0.074*** (3.44)
LEV	0.044 (0.53)	−0.056 (−1.35)
OCF	0.139 (1.14)	−0.008 (−0.12)
CASH	−0.077 (−0.71)	0.215*** (4.69)
MV	0.216*** (10.50)	0.231*** (25.84)
GROW	0.083*** (4.43)	0.109*** (10.55)
ROA	−0.132 (−0.86)	0.047 (0.49)
AGE	−0.037 (−1.61)	−0.006 (−0.38)
TANG	−0.097 (−0.86)	0.090* (1.75)
TOP1	0.004*** (2.87)	0.003*** (4.59)
DUAL	0.054** (2.26)	0.020* (1.68)
SOE	−0.022 (−0.40)	−0.085*** (−3.26)
Intercept	−3.990*** (−6.30)	−4.937*** (−14.50)
YearFE	YES	YES
FirmFE	YES	YES
N	3850	14787
adj. R2	0.889	0.857

^a This table shows the regression results for D&O insurance on carbon emissions under different legal risks. The dependent variable is carbon emissions of firms in millions of tons (CE). Column (1) reports the regression results if the company was sued in the previous year. Column (2) reports the results when the firm was not sued in the previous year. All control variables are defined in Table 2. All variables are winsorized at the 1st and 99th percentiles. *, **, and *** denote significance at the 10 %, 5 %, and 1 % level, respectively, and t statistics are in parentheses.

4.2. Impact of financial distress

Environmental governance requires huge investment in fixed assets and environmental protection activities. If a company is taking high financial risk, increasing investment in environmental governance will compete with more productive and profitable projects. Under such circumstances, companies are likely to prioritize acquiring short-term benefits over long-term and to allocate less funds toward environmental governance activities. We calculate financial distress (FD) following Altman (1968) and Ji et al. (2022). A smaller *FD* indicates a higher risk of corporate financial distress. Table 7, Column (1), suggests a stronger correlation between D&O insurance and carbon emissions in companies with more financial distress. D&O insurance may encourage risk-taking; therefore, managers tend to pursue short-term financial performance rather than improve environmental governance.

4.3. Impact of analysts' attention

Capital markets are considerably influenced by analysts. Studies have found that analysts affect the demand for company stocks and that executives who focus on analysts' earnings forecasts and recommendations make short-sighted decisions sacrificing long-term interests (Brauer and Wiersema, 2018), which may stimulate opportunistic behavior. Thus, these companies have more negative environmental behaviors. *ANALYSTS* is the number of analysts following. Interaction between *INSURED* and *ANALYSTS* (*INSURED_ANALYSTS*) is positive and significant (Table 7, Column (2)). This result indicates that companies attracting more attention tend to buy insurance to ensure economic benefits, which increases carbon emissions.

5. Conclusion

As more countries propose new commitments and environmental regimes, carbon emissions governance has emerged as key to achieving the net zero goal. Our results suggest that companies with D&O insurance have higher carbon emissions. We support the hypothesis that D&O insurance increases companies' risk-taking capacity and managers' opportunistic and self-interested motives.

Table 7
The impact of financial distress and analysts' attention.

Variable	(1)	(2)
INSURED	0.114*** (6.04)	−0.016 (−0.84)
FD	−0.008*** (−9.28)	
INSURED_FD	−0.007*** (−2.80)	
ANALYSTS		0.001** (2.46)
INSURED_ANALYSTS		0.012*** (11.01)
LEV	−0.175*** (−5.09)	−0.006 (−0.18)
OCF	−0.016 (−0.32)	−0.015 (−0.30)
CASH	0.318*** (9.60)	0.308*** (9.32)
MV	0.236*** (32.78)	0.193*** (26.54)
GROW	0.087*** (11.10)	0.090*** (11.61)
ROA	0.073 (1.04)	0.011 (0.15)
AGE	−0.027*** (−2.89)	−0.030*** (−3.11)
TANG	−0.000 (−0.01)	−0.008 (−0.20)
TOP1	0.003*** (6.27)	0.003*** (6.58)
DUAL	0.022** (2.44)	0.024*** (2.66)
SOE	−0.100*** (−4.96)	−0.088*** (−4.38)
Intercept	−4.575*** (−19.66)	−3.673*** (−15.65)
YearFE	YES	YES
FirmFE	YES	YES
N	23040	23051
adj. R2	0.846	0.846 ^a

^a This table shows the regression results of the impact of financial distress and analysts' attention on D&O insurance and carbon emissions. Carbon emissions of firms in millions of tons (CE) is the dependent variable. Column (1) reports the regression results with finance distress. Following Altman (1968) and Ji et al. (2022), we calculate financial distress (FD) as follows:

$FD = 1.2 \times \text{operational capital} / \text{total assets} + 1.4 \times \text{retained earnings} / \text{total assets} + 3.3 \times \text{EBIT} / \text{total assets} + 0.6 \times \text{market value of equity} / \text{book value of liabilities} + 0.999 \times \text{operational income} / \text{total assets}$ (2)

Column (2) reports the results with analysts' attention. All control variables are defined in Table 2. All variables are winsorized at the 1st and 99th percentiles. *, **, and *** denote significance at the 10 %, 5 %, and 1 % level, respectively, and t statistics are in parentheses.

Our study enriches the understanding of how D&O insurance and corporate carbon emissions are related. From the corporate risk-taking perspective, our findings suggest a detrimental effect of D&O insurance as it may stimulate managers' opportunistic motives. Organizations should be careful about insurance exclusions and clarify managers' and directors' responsibilities and authority.

Glossary

No field-specific terms were used in our article and we have nothing to disclose.

Declaration of generative AI in scientific writing

No AI tools were used during the preparation of this work and we have nothing to disclose.

CRedit authorship contribution statement

Qianyi Wang: Software, Formal analysis, Data curation. **Xinyi Lou:** Software, Formal analysis, Data curation, Conceptualization.

Zhan Wang: Writing – review & editing, Validation, Methodology, Conceptualization.

Data availability

We have described the data source in section 3.1.

Acknowledgements

We thank Samuel Vigne (editor), anonymous referees, Xu Guo, and the conference participants at the 2023 SBS International Conference for Finance.

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