

Can D&O insurance improve corporate ESG performance?

Jing Zhao

Nanjing Audit University <https://orcid.org/0000-0003-4327-7467>

Hanyou Xu (✉ saton@nau.edu.cn)

Nanjing Audit University <https://orcid.org/0000-0002-0854-8375>

Research Article

Keywords: Directors' and officers' liability insurance, ESG, Independent director function-performing effectiveness, Corporate risk-taking, Economic policy uncertainty, Industry competition

Posted Date: May 11th, 2022

DOI: <https://doi.org/10.21203/rs.3.rs-1641589/v1>

License: © ⓘ This work is licensed under a Creative Commons Attribution 4.0 International License. [Read Full License](#)

Abstract

D&O insurance has gained mature practice in developed countries. However, as of November 2021, no more than 15% of listed companies in China have purchased D&O insurance. Combining China's unique institutional culture and economic background, we examine the impact of D&O insurance on corporate ESG performance. The results show that D&O insurance significantly improves corporate ESG performance. Meanwhile, this positive relationship is affected by economic policy uncertainty and industry competition. Additional analysis suggests that the contribution of D&O insurance to ESG performance is achieved by improving independent director function-performing effectiveness and increasing corporate risk-taking. The findings of this paper have policy implications for a better understanding of the governance role of D&O insurance, encouraging companies to improve corporate ESG performance.

1. Introduction

Directors' and officers' (D&O) liability insurance is designed to protect the directors, supervisors, and senior management from personal liability that may stem from negligence or misconduct in the course of performing their regular duties (Lin et al. 2013; Aguir and Aguir 2020). D&O insurance has gained mature practice in developed countries. According to a survey by Tillinghast-Towers Perrin[1], 96% of U.S. companies and 88% of Canadian companies have purchased D&O insurance. In 2002, the China Securities Regulatory Commission issued the Code of Corporate Governance, which sets forth that listed companies can purchase D&O insurance for their directors and officers to protect their assets in the event of a lawsuit. However, as of November 2021, no more than 15% of listed companies in China have purchased D&O insurance. In 2020, the Luxin coffee's financial fraud incident broke out suddenly, and then it was revealed by investors that they had bought directors and executives with a large amount of D&O insurance. Whether the insurance can obtain claims and help investors recover losses has sparked a lot of discussions. D&O insurance has also received more attention from listed companies and academics as a result of Luxin Coffee.[2] With the establishment and improvement of the legal and capital market systems, D&O insurance has gradually gained popularity among emerging countries.

At the same time, with the gradual deterioration of the ecological environment and the acceleration of the global integration process, the world has shown an unprecedentedly high concern for sustainable development. The concept of sustainable development and corporate social responsibility has gained widespread public attention and recognition. As a systematic methodology to promote enterprise sustainability, ESG is a non-financial enterprise evaluation system focusing on the environment, society, and governance. It promotes enterprises to move from the pursuit of self-interest maximization to the pursuit of social value maximization, which is both a core framework and an inherent requirement for companies to pursue green development.

The growing focus on environmental changes, social events, and corporate responsibility have triggered a trend that a substantial body of literature developed to monitor ESG performance. By combing through the extant literature, we found most previous research on the factors influencing ESG performance has been based on the perspective of market, firm leadership, and ownership. As for market characteristics, many studies have provided evidence that a country's economic development (Cai et al. 2016), industry (Borghesi et al. 2014), political leanings of the state's citizens, the social capital of the county (Jha and Cox, 2015) affect ESG performance. Firm leadership characteristics include multinational board members, women leaders (McGuinness et al. 2017), married CEOs, CEO confidence (McCarthy et al. 2017), and CEO pay (Ikram et al. 2019). Other studies argue that ESG performance is associated with the size of institutional ownership, family ownership (El Ghoul et al. 2016), and state ownership. However, few empirical studies on enterprise ESG governance are based on the perspective of insurance contracts. Insurers cover the risk of decision-making failures by providing D&O insurance, which has more direct incentives and is more likely to exert ESG governance influence. So, can D&O insurance promote companies to improve ESG performance? What is the transmission mechanism? Does the impact of D&O insurance on ESG vary with corporate characteristics? Answering the above questions has a practical guiding role in improving corporate governance, restraining management opportunistic behavior, and promoting sustainable development of enterprises.

Using a sample of Chinese A-share listed companies from 2011 to 2020, this study investigates the impact of D&O insurance on corporate ESG performance. From a regression analysis of the data, followed by robustness tests, we reached the following conclusions. D&O insurance significantly improves corporate ESG performance. Meanwhile, this positive relationship is affected by economic policy uncertainty and industry competition. Additional analysis suggests that the contribution of D&O insurance to ESG performance is achieved by improving independent director function-performing effectiveness and increasing corporate risk-taking.

This paper contributes to the literature in three ways. First, our study enriched the literature on the factors influencing corporate ESG performance. Previous studies mostly discuss this issue from the perspective of market, firm leadership, and ownership. Empirical studies focused on the insurance perspective are insufficient, our study takes the D&O insurance as an example, which uncovers a new factor affecting corporate ESG performance and further enriches the literature on ESG performance. Second, our study provides a new perspective to study the consequences of D&O insurance. Extant literature on the governance function of D&O insurance tends to focus on the economic consequence of D&O insurance (Yuan et al. 2016; Wang et al. 2020). We, however, analyze the comprehensive governance consequences of D&O insurance from the perspective of ESG, expanding the research horizon of relevant literature. Third, our study revealed the transmission mechanisms of D&O insurance to ESG. It deepens the understanding of the relationship between D&O insurance and corporate ESG performance. Our study also provides practical guiding significance for management to improve ESG performance.

The remainder of this paper is organized as follows. The “Theoretical analysis and hypothesis developments” section develops our main hypotheses, the “Research Design” section refers to research design, and the “Empirical results” section presents the main empirical results and robustness tests. The “Additional analyses” section provides the intermediary mechanism tests. Finally, the “Conclusions and future perspective” section gives conclusions and policy suggestions.

[1] Towers Perrin is one of the world's largest global management and human resource consulting firms. Tillinghast - provides business management and actuarial consulting services to the insurance and financial industries, as well as risk management consulting services to a variety of public and private institutions.

[2] In April 2020, the fraud incident of Luxin Coffee suddenly broke out. Subsequently, investors discovered that Luxin Coffee had previously purchased D&O insurance with a large insured amount. Whether Luxin Coffee could get claims from the insurance company to help the majority of investors to recover part of the loss has become a hot topic of discussion for a while.

2. Theoretical Analysis And Hypothesis Developments

2.1 D&O insurance and ESG performance

ESG performance differs from traditional financial indicators in that it comprehensively considers whether an enterprise can achieve long-term sustainable development from three dimensions: environment, society, and corporate governance. Among them, E mainly emphasizes that enterprises take the initiative to protect the environment, adopt environmental protection measures and incorporate environmental protection into the company's constitution; S requires enterprises to comply with social morality, rule of law, and ethics, assume and protect the rights and interests of various stakeholders; G represents the corporate governance system established by the company to maintain orderly operation. Following the resource-based view (RBV), environmental and social activities can lead to the development of a competitive advantage within a company (Hull and Rothenberg, 2008; Nirino et al. 2021). Hence, companies have an incentive to improve their ESG performance to access resources that affect the survival and development of the company.

Previous studies have suggested that D&O insurance can provide a “bottom line” effect for the management in terms of behavior and personal property (Wang et al., 2020). However, this “bottom line” effect may have positive or negative effects on the management of the company. Therefore, D&O insurance may also have positive or negative effects on corporate ESG performance.

In terms of positive impact, D&O insurance can encourage managers to make positive progress, forcing managers to engage in responsible conduct and improve corporate ESG performance. On one hand, D&O insurance can lower directors' and officers' litigation exposures, alleviate the potential risk aversion problem and increase their risk appetite, thereby stimulating them to invest more in innovation (Hu et al. 2019). Moreover, before a company subscribes to D&O insurance, the insurance company often requires the client company to appoint enough independent directors to reduce the risk (O'Sullivan 2002). The independent directors are more inclined to focus on business development and governance efficiency (Wang and Lu 2013) to prove they are diligent and responsible. Meanwhile, the independence of independent directors enables them to make independent judgments on the company's decision-making and development strategies objectively and neutrally and to focus on long-term development rather than current interests (Wang and Chen 2018). Hence, independent directors are more likely to support green technology innovation, which has been increasingly emphasized by policymakers and academics alike as a mechanism for effectively solving environmental problems and enhancing firm sustainability (Kallio and Nordberg 2016).

On the other hand, after an enterprise subscribes to D&O insurance, the insurance company will participate in corporate governance as a third-party external supervisor, which can reduce the information asymmetry and investment concerns of external stakeholders, thus helping to improve the availability of exogenous financing. According to the “signaling” hypothesis, the fulfillment of environmental and social responsibilities will lead stakeholders to believe that the company's performance is good enough to support its continued sustainability practices. Hence, companies tend to undertake social responsibilities to form the reputation capital, which can also help the company better survive the legitimacy crisis especially when the company is affected by negative events (Dowling and Pfeffer 1975; Broadstock et al. 2021).

In contrast, the negative impact of D&O insurance is manifested in its “bottom line” effect that can induce unintended moral hazards, gradually becoming a “protective umbrella” for management's self-interested behavior (H. Chung and P. Wynn 2014). On one hand, the introduction of D&O insurance may reduce the diligence of management in performing their duties (Gillan and Panasian 2015; Jia and Tang 2018), leading to managerial opportunism. On the other hand, D&O insurance reduces the disciplining effect of shareholder litigation, which may lead to the waste or improper use of corporate resources and shareholders' interests. In turn, it may hurt business management and cause firms to reduce long-term corporate value enhancement activities, which finally hurts corporate ESG performance.

Therefore, we propose two competing hypotheses for the effect of D&O insurance on corporate ESG performance.

H1a: The purchase of D&O insurance improves corporate ESG performance, other things being equal.

H1b: The purchase of D&O insurance decreases corporate ESG performance, other things being equal.

2.2 The moderating effect of economic policy uncertainty

According to the real options theory, firms exercise increasingly prudent investment behavior and tend to reduce or postpone long-term ESG investment in response to the high uncertainty of economic policies (Bloom et al. 2016). This is because improving ESG performance requires a large amount of sunk costs, while companies prefer to hold more cash or increase dividend payout during a high EPU period. At the same time, the incentive and supervisory functions of D&O insurance are largely dependent on the external environment of the company (Jia and Liang 2013; Feng et al. 2017). On one hand, the external environment may affect people psychologically and change their expectations. The theory of attribution suggests that people tend to underestimate the impact of external factors and overestimate the impact of internal or personal factors. Thus, directors and officers are more likely to be blamed for the enterprise's distress, which rises the legitimacy risk faced by management (Lou et al. 2022). Thus, the "bottom line" effect provided by D&O insurance is diminished when EPU grows. On the other hand, EPU may reduce the observability of management's diligence and create information asymmetries between management and the stakeholders (Boyle and Guthrie 2003), encouraging directors and officers to adopt opportunistic practices (Johnson et al. 2000; Bae et al. 2012) rather than improving corporate ESG performance. Following the empirical evidence and the above discussion, we propose the following hypothesis:

H2: Economic policy uncertainty negatively moderates the relationship between D&O insurance and corporate ESG performance.

2.3 The moderating effect of industry competition

According to strategic management theory and signaling theory, companies need to pay attention to the dynamic requirements of various stakeholders to gain a sustainable competitive advantage. The intensified competition will inevitably lead to a large number of substitutes in the market. At this time, consumers tend to choose goods produced by companies with a good reputation and excellent ESG performance (Brammer and Pavelin, 2004). Therefore, companies have the incentive to practice environmental, social, and corporate governance responsibilities to release positive signals about their operations and development to the outside. In addition, the competitive information hypothesis suggests that when the industry becomes more competitive, it provides a more transparent information environment for the management. Therefore, independent directors can perform advisory and monitoring functions at lower monitoring costs. Meanwhile, it also makes management under greater pressure for performance evaluation and is faced with a higher risk of business failure and departure. At this time, the signaling effect of the company's subscription to D&O insurance is reduced, and the effect on ESG performance is diminished. Based on this, this paper proposes the following hypothesis:

H3: Industry competition negatively moderates the relationship between D&O insurance and corporate ESG performance.

3. Research Design

3.1 Sample selection and data source

To ensure consistency and availability of research data, we based our sample selection on all firms listed on the Shanghai and Shenzhen Stock Exchanges from 2011 to 2020. At present, the China Securities Regulatory Commission (CSRC) follows the principle of voluntary disclosure to disclose information related to D&O insurance. For this reason, we manually compile information about D&O insurance (*Insured*) by reviewing the annual reports of listed companies and combining them with the announcements of listed companies downloaded from China Information Bank. ESG disclosure scores (*ESG*) are obtained from Bloomberg, economic policy uncertainty (*Epu*) constructed from the China Economic Policy Uncertainty Index. The rest of the data are obtained from the China Stock Market & Accounting Research (CSMAR) Database. To improve the reliability and validity of the data, the initial sample is excluded as follows: (1) Financial and insurance industry; (2) ST and *ST companies; (3) Companies with missing relevant financial data. After the above processing, we finally obtained a sample of 6223 firm-years observations. To avoid the impact of extreme values on the accuracy of the empirical results, all continuous variables are Winsorized at the upper and lower 1% levels. The statistical analysis software is Stata 16.0.

3.2 Variable definition

(1) Explained variable (ESG)

Bloomberg measures ESG performance in terms of environment (E), society (S), and governance (G) dimensions. The scale ranges from 0.1 to 100, meaning that the more data disclosed, the higher the level of disclosure, and the better the ESG performance. In addition, the Bloomberg database is weighted based on the importance of the data points and adjusted accordingly for each industry.

(2) Main explanatory variable (Insured)

Overseas research on D&O insurance mostly uses the amount of D&O insurance as a proxy variable. Chinese companies are not mandated to disclose the specific amount of D&O insurance. Therefore, we draw on the studies of Lin et al. (2011) and Yuan et al. (2016) to select a binary dummy variable *Insured* to measure the purchase of D&O insurance. A listed company is considered to have purchased D&O insurance if the

information related to the purchase of D&O insurance is disclosed in its announcement and voted by the board of directors and shareholders' meeting, $Insured = 1$; conversely, $Insured = 0$.

(3) Moderating variables

Our study draws on the Chinese economic policy uncertainty index developed and compiled by Baker et al. (2013) to measure economic policy uncertainty. However, the economic policy uncertainty data given by Baker et al. (2013) are monthly data. Following Zhang and Wang (2021), the annual data on economic policy uncertainty is obtained by arithmetically averaging the monthly data for each year and dividing it by 100.

Referring to scholars such as Peress (2010) and Sun et al. (2021), the industry Lerner index is used to measure the degree of industry competition. The industry Lerner index is obtained by using the ratio of the operating revenue of individual companies to the operating revenue of a single industry and then weighting the individual Lerner index within the industry.

$$\text{IndividualLernerIndex} = (\text{OperatingRevenue} - \text{OperatingCosts} - \text{SellingExpenses} - \text{AdministrativeExpenses}) / \text{OperatingRevenue}$$

It should be noted that the higher the industry Lerner Index is, the stronger the monopoly power in the industry and the less competitive the industry is.

(4) Control variables

Our firm-specific control variables are defined in previous studies such as Arora and Dharwadkar (2011) and Zamir et al. (2020), to capture the effect of other factors on ESG performance. The detailed definitions of all variables used in this study are presented in Appendix 1.

3.3 Model Design

Model (1) is used to test hypothesis $H1$, which examines the effect of D&O insurance on corporate ESG performance. Our study uses the firm-fixed effects model to control for unobserved time-invariant firm characteristics. We also use the heteroscedasticity-robust standard errors clustered by firms for statistical inference.

$$ESG_{it} = \alpha_0 + \alpha_1 Insured_{it} + \alpha_2 Controls_{it} + \sum Firm + \sum Year + \epsilon_{it}$$

1

To test how economic policy uncertainty and industry competition influence the relationship between D&O insurance and corporate ESG performance, the baseline regression (1) is augmented as follows:

$$ESG_{it} = \beta_0 + \beta_1 Insured_{it} + \beta_2 Epu_{it} + \beta_3 Insured_{it} * Epu_{it} + \beta_4 Controls_{it} + \sum Firm + \sum Year + \epsilon_{it}$$

2

$$ESG_{it} = \gamma_0 + \gamma_1 Insured_{it} + \gamma_2 Gglerner_{it} + \gamma_3 Insured_{it} * Gglerner_{it} + \gamma_4 Controls_{it} + \sum Firm + \sum Year + \epsilon_{it}$$

3

4. Empirical Results

4.1 Descriptive statistics

Table 1 shows the descriptive statistics results of the main variables. The mean value of ESG performance (ESG) is 22.43 and the standard deviation is 6.341, indicating that there are significant differences in ESG performance among different companies. The mean value of D&O insurance ($Insured$) is 0.137, which shows that only 13.7% of the enterprises in the study sample have purchased D&O insurance, reflecting that the percentage of enterprises purchasing D&O insurance among A-share listed companies in China is still low and there is a significant gap with Western countries.

Table 1
Descriptive statistics

Variables	Obs.	Mean	SD	Min	Max
ESG	6223	22.430	6.341	11.980	44.810
Insured	6223	0.137	0.344	0.000	1.000
Lev	6223	0.471	0.187	0.075	0.844
CFO	6223	0.062	0.062	-0.101	0.241
Size	6223	23.24	1.307	20.580	27.030
Incentives	6223	14.75	0.680	13.300	16.720
Mgtexpense	6223	0.074	0.052	0.007	0.273
Audit4	6223	0.133	0.340	0.000	1.000
State	6223	0.596	0.491	0.000	1.000
Dual	6223	0.163	0.369	0.000	1.000

4.2 Baseline regression results

Table 2 presents the regression results for the test of H1. As shown in columns (1) and (2) of Table 2, regardless of whether control variables were included or not, D&O insurance coefficients ($\alpha_1 = 5.491$ and 2.921 , respectively) were significantly positive at the 1% level, indicating that D&O insurance can significantly enhance corporate ESG performance. The regression results reported in columns (2) of Table 2 further confirm H1a.

Table 2
The impact of D&O insurance on ESG performance

	(1)	(2)
	ESG	ESG
Insured	5.491 ^{***}	2.921 ^{***}
	(18.811)	(11.129)
Lev		-1.224 ^{***}
		(-2.609)
CFO		2.759 ^{**}
		(2.501)
Size		1.569 ^{***}
		(19.400)
Incentives		0.457 ^{***}
		(3.744)
Mgtexpense		2.770 [*]
		(1.950)
Audit4		3.169 ^{***}
		(10.986)
State		0.723 ^{***}
		(4.836)
Dual		-0.327 [*]
		(-1.773)
Constant	17.690 ^{***}	-22.939 ^{***}
	(50.760)	(-11.061)
Obs.	6223	6223
Adj.R ²	0.161	0.316
Year	Yes	Yes
Industry	Yes	Yes
Notes: ***, **, and * indicate significant difference at the 1%, 5%, and 10% levels, respectively. T-statistics are reported in parentheses and are based on robust standard errors.		

4.3 Regression results for moderating effects

Table 3 presents the regression results for the test of the moderating effect of Economic Policy Uncertainty and Industry competition. Columns (1) to (2) are respectively based on the regression results of models (2) to (3). Table 3 shows that when economic policy uncertainty (*Epu*) increases, the contribution of D&O insurance to corporate ESG performance is weakened, which suggests that the interaction effect of economic policy uncertainty and D&O insurance have a substitution effect on corporate ESG performance. In addition, based on the new institutional economics, it has been argued that competition can generate financial pressure on firms and management, thus forming an alternative governance mechanism (Aghion et al., 1999). Therefore, a more competitive market environment is less conducive to the role of fault-tolerant incentives. Column (2) of Table 3 shows that the higher the industry competition, the less effect introducing D&O insurance on ESG performance.

Table 3
Test for moderating effects

ESG	(1)	(2)
Insured	2.908***	2.921***
	(11.141)	(11.072)
EPU	-7.680***	
	(-3.859)	
EPU*Insured	-8.408***	
	(-4.406)	
Gglerner		-3.563***
		(-5.304)
Gglerner*Insured		4.175*
		(1.954)
CVs		
Constant	-10.214**	-23.998***
	(-2.530)	(-11.584)
Obs.	6223	6223
Adj.R ²	0.319	0.321
Year	Yes	Yes
Industry	Yes	Yes
Notes: ***, **, and * indicate significant difference at the 1%, 5%, and 10% levels, respectively. T-statistics are reported in parentheses and are based on robust standard errors.		

5. Robustness Tests

5.1 Dealing with endogeneity

It is possible that the purchase of D&O insurance is endogenous, which is to say, both D&O insurance and corporate ESG performance are jointly determined by unobservable factors. In this section, we aim to address this type of endogeneity issue using the following approaches.

First, to mitigate the possible self-selection problem of the purchase of D&O insurance that affects the accuracy of the research results, this paper adopts Heckman's two-stage regression. In the first stage, we consider the influence of factors such as financial status and corporate governance characteristics on the demand for D&O insurance, and build a Probit model to estimate the inverse Mills ratio (*IMR*) of directors' liability insurance for listed companies; In the second stage, we add the inverse Mills ratio (*IMR*) of D&O insurance for listed companies estimated in the first stage to model (1). Columns (1) of Table 4 suggest that our conclusion is still robust.

Second, we applied the instrumental variable (*IV*) estimation method. Drawing on Yuan et al. (2018) and Gao et al. (2021), we use the overseas work background of executives (*Abroad*) as an instrumental variable for D&O insurance to carry out 2SLS regression. The instrument variable is measured by taking the logarithm of the number of corporate executives with overseas working backgrounds. On one hand, the coverage rate of D&O insurance in developed countries such as Europe and the United States has reached over 90%, thus executives with overseas working backgrounds have a better understanding of the mechanism of the role of directors' liability insurance. According to the "branding theory" and "cognitive consistency theory", the values and preferences of executives with overseas working backgrounds are influenced by western companies, and they tend to purchase D&O insurance after returning to work in China. Therefore, we expect that the higher the number of executives with overseas working backgrounds, the more likely the company is to purchase D&O insurance, which satisfies the correlation condition of an instrumental variable. On the other hand, the executive's overseas work background can hardly have a direct impact on the corporate ESG performance, satisfying the exogenous condition of the instrumental variable. The regression results in columns (2) and (3) of Table 4 show that the regression coefficient of D&O insurance (*Insured*) continues to positively contribute to corporate ESG performance at the 5% significance level. Meanwhile, the F-value of the first stage regression of the instrumental variables is greater than 10, and the Wald F statistic in the second stage

regression is greater than the Stock-Yogo critical value of 16.38 at the 10% level, which rejects the hypothesis of weak instrumental variables and indicates that the selected instrumental variables are valid.

Table 4
Endogenous test

	(1)	(2)	(3)
	ESG	Insured	ESG
Insured	2.920 ^{***}		12.00 ^{**}
	(11.126)		(2.83)
Abroad		0.045 ^{***}	
		(4.52)	
IMR	0.056		
	(0.131)		
CVs	Yes	Yes	Yes
F	63.33	14.92	171.6
Obs.	6223	6223	6223
Year	Yes	Yes	Yes
Industry	Yes	Yes	Yes
Kleibergen-Paap rk LM statistic			14.779
Cragg-Donald Wald F statistic			20.399
			[16.38]
Notes: ^{***} , ^{**} , and [*] indicate significant difference at the 1%, 5%, and 10% levels, respectively. T-statistics are reported in parentheses and are based on robust standard errors. Values in square brackets are critical values at the 10% level of the Stock-Yogo test.			

5.2 Other robustness tests

First, the estimation error caused by omitted variables is further solved to a certain extent by controlling for individual effects and year effects in the baseline model.

Second, to exclude the possible existence of endogeneity problems such as reverse causality, we lag the explanatory variable (*Insured*) in the model (1) by one period. As shown in columns (2) of Table 5, which suggests that our conclusion is still robust.

Third, to more accurately compare the impact of the introduction of D&O insurance on ESG performance, we exclude the industries that never introduced D&O insurance in recent years. The regression results are reported in column (3) of Table 5, we find that our results hold after excluding these samples.

Fourth, since the introduction of D&O insurance by Chinese listed firms is still low, there may be a screening phenomenon of insured firms by insurance companies, i.e., only firms with inherently excellent financial and ESG performance can purchase D&O insurance. For this reason, we performed a propensity score-matched (PSM) estimation. To begin with, the Probit model is set up, with D&O Insurance (*Insured*) as the dependent variable. The independent variables include *Balance Sheet Ratio*, *Cash Ratio*, *Corporate Size*, *Executive Incentive*, *Management Expense Ratio*, *Corporate Age*, *Top Ten Shareholders' shareholding*, *Profitability*, and *Corporate Growth*. The comparison of differences before and after matching variables is presented in Appendix 2. The estimation applies a one-to-one pairing principle to the matching sample. Based on the new paired sample, column (4) of Table 5 shows similar results to our main regression, which supports that our results are not driven by self-selection.

Table 5
Other robustness tests

ESG	(1)	(2)	(3)	(4)
Insured	2.352 ^{***}		2.906 ^{***}	2.321 ^{***}
	(5.830)		(11.086)	(7.078)
L.Insured		3.118 ^{***}		
		(10.569)		
Lev	-1.312 ^{**}	-1.022 ^{**}	-1.239 ^{***}	1.276
	(-2.214)	(-2.009)	(-2.596)	(1.137)
CFO	1.206	3.358 ^{***}	2.818 ^{**}	4.134
	(1.334)	(2.725)	(2.493)	(1.512)
Size	1.036 ^{***}	1.613 ^{***}	1.583 ^{***}	2.165 ^{***}
	(5.556)	(18.597)	(19.336)	(13.389)
Incentives	0.561 ^{***}	0.532 ^{***}	0.482 ^{***}	0.833 ^{***}
	(3.578)	(4.028)	(3.875)	(3.295)
Mgtexpense	4.338 ^{**}	2.329	3.024 ^{**}	20.607 ^{***}
	(2.562)	(1.517)	(2.078)	(4.762)
Audit4	1.162 ^{**}	3.348 ^{***}	3.144 ^{***}	3.766 ^{***}
	(2.039)	(10.733)	(10.896)	(8.385)
State	0.311	0.761 ^{***}	0.752 ^{***}	0.876 ^{**}
	(1.029)	(4.721)	(4.985)	(2.262)
Dual	-0.056	-0.262	-0.299	-0.795
	(-0.295)	(-1.303)	(-1.592)	(-1.421)
Constant	-14.136 ^{***}	-25.769 ^{***}	-21.703 ^{***}	-45.863 ^{***}
	(-3.172)	(-11.498)	(-9.952)	(-10.107)
Obs.	6223	5492	6094	1708
Adj.R ²	0.774	0.325	0.313	0.426
Year	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes
Firm	Yes	No	No	No
Notes: ***, **, and * indicate significant difference at the 1%, 5%, and 10% levels, respectively. T-statistics are reported in parentheses and are based on robust standard errors.				

6. Additional Analyses

6.1 Mediating effect analysis

In the previous section, we provide evidence that D&O insurance plays an important role in improving corporate ESG performance, but the transmission mechanism between the two remains at the theoretical level. In this section, we construct models (4)-(6) to empirically test two possible mediating paths: improving independent director function-performing effectiveness (*Scores*) and increasing corporate risk-taking (*Risk*).

$$ESG_{it} = \alpha_0 + \alpha_1 Insured_{it} + \alpha_2 Controls_{it} + \sum Firm + \sum Year + \epsilon_{it}$$

$$Scores_{it}/Risk_{it} = \delta_0 + \delta_1 Insured_{it} + \delta_2 Controls_{it} + \sum Firm + \sum Year + \epsilon_{it}$$

5

$$ESG_{it} = \mu_0 + \mu_1 Insured_{it} + \mu_2 Scores_{it}/Risk_{it} + \mu_3 Controls_{it} + \sum Firm + \sum Year + \epsilon_{it}$$

6

Following Jia and Tang (2018), this study selects four indicators: the busyness of independent directors, the level of independent directors' remuneration, the number of meetings attended by independent directors, and the proportion of independent directors, using the entropy method to calculate the comprehensive score of independent directors' performance, the specific indicators are shown in Table 6. In addition, we also use the comprehensive score of independent directors' performance calculated by the CRITIC assignment method as a robustness test.

Table 6
Effectiveness of independent directors' performance

Variable	Definition	Measurement
Busy	The busyness of independent directors	The average number of companies concurrently held by independent directors
Payments	Independent directors' remuneration	Natural logarithm of the average remuneration of independent directors
Meetings	Number of meetings attended by independent directors	Number of Attendance - Number of Delegated Attendance - Number of Absences
Ind_ratio	The proportion of independent directors	Number of independent directors/number of directors

The regression results are presented in Table 7, D&O insurance improves the effectiveness of independent directors in performing their duties. When a company purchases D&O insurance, the independent directors will actively promote the effectiveness of their performance to prove they are diligent and responsible. Further, the extensive experience and social resources of independent directors can also send positive signals and alleviate information asymmetry, thus significantly improving the ESG performance of the company.

Table 7
Intermediary mechanism tests (1)

	(1)	(2)	(3)	(4)	(5)
	ESG	Score1	ESG	Score2	ESG
Insured	2.966***	0.009***	2.924***	0.258***	2.880***
	(11.168)	(5.295)	(11.004)	(6.459)	(10.867)
Score1			4.816***		
			(2.627)		
Score2					0.336***
					(4.488)
CVs	Yes	Yes	Yes	Yes	Yes
Constant	-22.915***	0.057***	-23.191***	0.008	-22.918***
	(-11.037)	(4.109)	(-11.121)	(0.020)	(-11.097)
Obs.	6213	6213	6213	6213	6213
Adj.R ²	0.317	0.068	0.317	0.168	0.319
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes

Notes: ***, **, and * indicate significant difference at the 1%, 5%, and 10% levels, respectively. T-statistics are reported in parentheses and are based on robust standard errors.

Referring to scholars such as John et al. (2008) and He et al. (2019), we use the volatility of a firm's earnings to measure corporate risk-taking. First, as shown in model (7), we subtract the industry average from the company's annual Roa to mitigate the effects of industry and cycles. Second, as

shown in models (8) and (9), we take every five years (t-2 to t+2) as an observation period and calculate the standard deviation and extreme deviation of industry-adjusted Roa (Adj_Roa_{it}). Finally, to make the results more intuitive, we multiply the above results by 100 to obtain *Risk1* and *Risk2* as proxies for the level of enterprise risk-taking.

$$Adj_Roa_{it} = \frac{EBIT_{it}}{ASSET_{it}} - \frac{1}{\bar{X}} \sum_{k=1}^X \frac{EBIT_{it}}{ASSET_{it}}$$

7

$$Risk_{it} = \sqrt{\frac{1}{T-1} \sum_{t=1}^T (Adj_Roa_{it} - \frac{1}{T} \sum_{t=1}^T Adj_Roa_{it})^2} \quad | T = 5(8)$$

$$Risk2_{it} = Max(Adj_Roa_{it}) - Min(Adj_Roa_{it})$$

9

Columns (2) and (4) of Table 8 indicate that D&O insurance increases enterprise risk-taking. Further, after adding the Risk1/Risk2 to model (4), the coefficient of *Insured* is increased from 2.418, when there is no mediating variable, to 2.433. It indicates that D&O insurance can lower directors' and officers' litigation exposures, and increase enterprise risk-taking. Meanwhile, the underwriting effect of D&O insurance can transfer the financial losses caused by the top management's decision errors to the insurance company, thus greatly eliminating the managers' concerns and motivating them to choose green innovation activities that are beneficial to improving corporate ESG performance.

Table 8
Intermediary mechanism tests (2)

	(1)	(2)	(3)	(4)	(5)
	ESG	Risk1	ESG	Risk2	ESG
Insured	2.418 ^{***}	0.006 ^{**}	2.433 ^{***}	0.013 ^{**}	2.433 ^{***}
	(8.343)	(2.464)	(8.384)	(2.332)	(8.385)
Risk1			-2.602 ^{**}		
			(-2.163)		
Risk2					-1.157 ^{**}
					(-2.293)
CVs	Yes	Yes	Yes	Yes	Yes
Constant	-16.326 ^{***}	0.093 ^{***}	-16.085 ^{***}	0.240 ^{***}	-16.049 ^{***}
	(-7.307)	(3.678)	(-7.210)	(3.962)	(-7.193)
Obs.	4751	4751	4751	4751	4751
Adj.R ²	0.286	0.117	0.287	0.120	0.287
Year	Yes	Yes	Yes	Yes	Yes
Industry	Yes	Yes	Yes	Yes	Yes
Notes: ***, **, and * indicate significant difference at the 1%, 5%, and 10% levels, respectively. T-statistics are reported in parentheses and are based on robust standard errors.					

7. Conclusions And Future Research Directions

7.1 Conclusions

Using a sample of Chinese A-share listed companies from 2011 to 2020, this study investigates the impact of D&O insurance on corporate ESG performance. We find that D&O insurance can improve corporate ESG performance and when economic policy uncertainty and industry competition rise, the contribution of D&O insurance to ESG performance weakens. Additional analysis suggests that this promotion is achieved by improving independent director function-performing effectiveness and increasing corporate risk-taking.

The enlightenment offered by our study lies in the following: First, from the perspective of enterprises, D&O insurance can have a positive governance effect on improving non-financial performance. It is beneficial to help enterprises to manage risk, achieve sustainable returns and enhance the enterprise's sustainable competitiveness. Considering China's capital market in the special period of emerging and transition, listed companies should be encouraged to introduce D&O insurance. Second, from the perspective of government, Legislators and regulatory authorities should actively promote the corporate governance effects and risk management functions of D&O insurance, and promote the full penetration of D&O insurance in listed companies. At the same time, regulators should continuously improve the institutional construction to provide a good institutional environment for the governance function of D&O insurance and improve the construction of China's modern enterprise system. Third, in terms of the external environment in which D&O plays a role in ESG, companies should make reasonable use of D&O insurance as a fault-tolerant incentive mechanism to enhance their ESG performance when the industry is highly competitive. In addition, when there is more uncertainty in macroeconomic policies, the limited effect of introducing D&O insurance on enhancing ESG performance should also be considered.

7.2 Limitations and further research

Constrained by the availability of data and the level of research, there are some limitations in this paper. The China Securities Regulatory Commission (CSRC) has not yet made it mandatory for companies to disclose information related to D&O insurance subscriptions, and therefore detailed data on D&O insurance premiums and insurance amounts are not fully available. Therefore, we can only examine the economic impact of D&O insurance in the form of dummy variables, which can be improved in subsequent studies as corporate information disclosure becomes more transparent and specific. In addition, the governance functions, pathways, and interactions with other mechanisms of D&O insurance can be further studied to maximize its positive governance functions.

Declarations

Acknowledgments The authors express gratitude to all those who helped us during the writing of the paper and acknowledge the advice of the anonymous reviewers to improve the quality of this study.

Author contribution Conceptualization: JZ and HX. Methodology: JZ. Writing-original draft preparation: JZ. Writing-review and editing: JZ and HX. All authors have read and approved the final manuscript.

Data availability The datasets used during the current study are available from the corresponding author on reasonable request.

Statements and Declarations

Funding This research was funded by the 2021 Research Innovation Program of Jiangsu Province [grant number KYCX21_1905], the third phase of the advantageous discipline construction project of Jiangsu University (business administration), and the Youth and Blue Project of Jiangsu university.

Ethics approval Not applicable.

Competing interests The authors declare no competing interests.

References

1. Aghion P, Dewatripont M, Rey P (1999) Competition, financial discipline, and growth. *Rev Econ Stud* 66(4): 825–852. <https://doi.org/10.1111/1467-937x.00110>
2. Aguir I, Aguir W (2020) Director and officer liability protection and firm value: unintended consequences. *Financ Res Lett* 32. <https://doi.org/10.1016/j.frl.2019.04.033>
3. Arora P, Dharwadkar R (2011) Corporate governance and corporate social responsibility: The moderating roles of attainment discrepancy and organization slack. *Corp Gov-Oxford* 19(2): 136–152. <https://doi.org/10.1111/j.1467-8683.2010.00843.x>
4. Bae K-H, Baek J-S, Kang J-K, Liu W-L (2012) Do controlling shareholders' expropriation incentives imply a link between corporate governance and firm value?. *J Financ Econ* 105(2): 412–435. <https://doi.org/10.1016/j.jfineco.2012.02.007>
5. Bloom N, Draca M, Van Reenen J (2016) Trade induced technical change? The impact of Chinese imports on innovation, and productivity. *Rev Econ Stud* 83(1): 87–117. <https://doi.org/10.1093/restud/rdv039>
6. Borghesi R, Houston J F, Naranjo A (2014) Corporate socially responsible investments: CEO altruism, reputation, and shareholder interests. *J Corp Financ* 26: 164–181. <https://doi.org/10.1016/j.jcorpfin.2014.03.008>
7. Boyle G W, Guthrie G A (2003) Investment, uncertainty, and liquidity. *J Finance* 58(5): 2143–2166. <https://doi.org/10.1111/1540-6261.00600>
8. Brammer S, Pavelin S (2004) Building a good reputation. *Eur Manag J* 22(6): 704–713. <https://doi.org/10.1016/j.emj.2004.09.033>

9. Broadstock D C, Chan K, Cheng L T W, Wang X (2021) The role of ESG performance during times of financial crisis: Evidence from COVID-19 in China. *Finance Res Lett* 38: 101716. <https://doi.org/10.1016/j.frl.2020.101716>
10. Cai Y, Pan C H, Statman M (2016) Why do countries matter so much in corporate social performance? *J Corp Financ* 41: 591–609. <https://doi.org/10.1016/j.jcorpfin.2016.09.004>
11. Dowling J, Pfeffer J (1975) Organizational legitimacy: social values and organizational behavior. *Sociol Perspect* 18(1): 122–136. <https://doi.org/10.2307/1388226>
12. El Ghoul S, Guedhami O, Wang H, Kwok C C Y (2016) Family control and corporate social responsibility. *J Bank Financ* 73: 131–146. <https://doi.org/10.1016/j.jbankfin.2016.08.008>
13. Feng L, Kong X, Cao H (2017) Directors' and Officers' Liability insurance and cost of capital—Empirical evidence from channels of information quality. *Account Res* (11): 65–71 + 97 (in Chinese). <https://doi.org/10.3969/j.issn.1003-2886.2017.11.012>
14. Gao T, Zhang Y, Xu H (2021) D&O insurance and the quality of internal control of enterprises—based on empirical evidence of A-share listed companies. *J Financ Res* (05): 33–48. <https://doi.org/10.13490/j.cnki.frr.2021.05.003>
15. Gillan S L, Panasian C A (2015) On lawsuits, corporate governance, and directors' and officers' liability insurance. *J Risk Insur* 82(4): 793–822. <https://doi.org/10.1111/jori.12043>
16. H. Chung H, P. Wynn J (2014) Corporate governance, directors' and officers' insurance premiums, and audit fees. *Manag Audit J* 29(2): 173–195. <https://doi.org/10.1108/maj-04-2013-0856>
17. He Y, Yu W, Yang J (2019) CEOs with rich career experience, corporate risk-taking, and the value of enterprises. *China Ind Econ* (09): 155–173 (in Chinese). <https://doi.org/10.19581/j.cnki.ciejournal.2019.09.009>
18. Hu G, Zhao Y, Hu J (2019) Directors' and officers' liability insurance, risk tolerance, and enterprise independent innovation. *Manag World* (8): 121–135 (in Chinese). <https://doi.org/10.19744/j.cnki.11-1235/f.2019.0110>
19. Hull C E, Rothenberg S (2008) Firm performance: the interactions of corporate social performance with innovation and industry differentiation. *Strategic Manage J* 29(7): 781–789. <https://doi.org/10.1002/smj.675>
20. Ikram A, Li Z, Minor D (2019) CSR-contingent executive compensation contracts. *J Bank Financ*. <https://doi.org/10.1016/j.jbankfin.2019.105655>
21. Jha A, Cox J (2015) Corporate social responsibility and social capital. *J Bank Financ* 60: 252–270. <https://doi.org/10.1016/j.jbankfin.2015.08.003>
22. Jia N, Liang C (2013) Directors' and officers' liability insurance, institutional environment and corporate governance—Based on the earnings management of publicly listed companies in China. *Insur Stud* (07): 57–67 (in Chinese). <https://doi.org/10.13497/j.cnki.is.2013.07.006>
23. Jia N, Tang X (2018) Directors' and officers' liability insurance, independent director behavior, and governance effect. *J Risk Insur* 85(4): 1013–1054. <https://doi.org/10.1111/jori.12193>
24. John K, Litov L, Yeung B (2008) Corporate governance and risk-taking. *The J Financ* 63(4): 1679–1728. <https://doi.org/10.1111/j.1540-6261.2008.01372.x>
25. Johnson S, Boone P, Breach A, Friedman E (2000) Corporate governance in the Asian financial crisis. *J Financ Econ* 58(1–2): 141–186. [https://doi.org/10.1016/s0304-405x\(00\)00069-6](https://doi.org/10.1016/s0304-405x(00)00069-6)
26. Kallio T J, Nordberg P (2016) The evolution of organizations and natural environment discourse. *Organ Environ* 19(4): 439–457. <https://doi.org/10.1177/1086026606294955>
27. Lin C, Officer M S, Wang R, Zou H (2013) Directors' and officers' liability insurance and loan spreads. *J Financ Econ* 110(1): 37–60. <https://doi.org/10.1016/j.jfineco.2013.04.005>
28. Lin C, Officer M S, Zou H (2011) Directors' and officers' liability insurance and acquisition outcomes. *J Financ Econ* 102(3): 507–525. <https://doi.org/10.1016/j.jfineco.2011.08.004>
29. Lou Z, Chen S, Yin W, Zhang C, Yu X (2022) Economic policy uncertainty and firm innovation: Evidence from a risk-taking perspective. *Int Rev Econ Financ* 77: 78–96. <https://doi.org/10.1016/j.iref.2021.09.014>
30. McCarthy S, Oliver B, Song S (2017) Corporate social responsibility and CEO confidence. *J Bank Financ* 75: 280–291. <https://doi.org/10.1016/j.jbankfin.2016.11.024>
31. McGuinness P B, Vieito J P, Wang M (2017) The role of board gender and foreign ownership in the CSR performance of Chinese listed firms. *J Corp Financ* 42: 75–99. <https://doi.org/10.1016/j.jcorpfin.2016.11.001>
32. Nirino N, Santoro G, Miglietta N, Quaglia R (2021) Corporate controversies and company's financial performance: Exploring the moderating role of ESG practices. *Technol Forecast Soc* 162. <https://doi.org/10.1016/j.techfore.2020.120341>
33. O'sullivan N (2002) The demand for directors' and officers' insurance by large UK companies. *Eur Manag J* 20(5): 574–583. [https://doi.org/10.1016/s0263-2373\(02\)00096-8](https://doi.org/10.1016/s0263-2373(02)00096-8)
34. Peress J (2010) Product market competition, insider trading, and stock market efficiency. *J Financ* 65(1): 1–43. <https://doi.org/10.1111/j.1540-6261.2009.01522.x>

35. Sun C, Wang H, Wang P (2021) Influence of corporate core competence on supply chain finance: Financial support or occupation? *China Soft Science* (06): 120–134 (in Chinese). <https://doi.org/10.3969/j.issn.1002-9753.2021.06.012>
36. Wang F, Chen F (2018) Board governance, environmental regulation, and green technology innovation—Empirical test based on listed companies in China's heavy polluting industry. *Studies Sci* 36(02): 361–369 (in Chinese). <https://doi.org/10.16192/j.cnki.1003-2053.2018.02.019>
37. Wang J, Lu X (2013) Director's reputation, busy boards, and the quality of information disclosure. *Journal of Audit & Economics* 28(04): 67–74 (in Chinese). <https://doi.org/cnki:sun:sjyj.0.2013-04-009>
38. Wang J, Zhang J, Huang H, Zhang F (2020) Directors' and officers' liability insurance and firm innovation. *Econ Model* 89: 414–426. <https://doi.org/10.1016/j.econmod.2019.11.011>
39. Yuan R, Sun J, Cao F (2016) Directors' and officers' liability insurance and stock price crash risk. *J Corp Financ* 37: 173–192. <https://doi.org/10.1016/j.jcorpfin.2015.12.015>
40. Zamir F, Shailer G, Saeed A (2020) Do corporate social responsibility disclosures influence investment efficiency in the emerging markets of Asia? *Int J Manag Financ* 18(1): 28–48. <https://doi.org/10.1108/ijmf-02-2020-0084>
41. Zhang S, Wang X (2021) Directors' and Officer' liability insurance and accounting information quality—The moderating role of economic policy uncertainty. *Insur Stud* (05): 33–49 (in Chinese). <https://doi.org/10.13497/j.cnki.is.2021.05.003>

Appendix 1

Table 9 Variables definition

Variable	Measurement
ESG	Bloomberg Database ESG Performance
Insured	Dummy variable. Takes the value of 1 if the company purchased director's liability insurance during the year, and 0 otherwise.
Lev	Total liabilities / total assets
Mgtexpense	Total administrative expenses/total assets
CFO	Net cash flow from operating activities / total assets
Size	Natural logarithm of total assets
Incentives	Natural logarithm of the annual salary of the top three executives in terms of annual salary amount
Dual	Dummy variable. If the general manager and the chairman are the same people, the value is 1, otherwise, it is 0.
Audit4	Dummy variable. Its value is 1 if it is audited by the Big 4 and 0 otherwise.
State	Dummy variables. State-owned enterprises take 1, otherwise, take 0.
Firm	Individual dummy variables
Year	Year dummy variables

Appendix 2

Table 10 Comparison of differences before and after matching variables

Variable	U (Before matching)	Average value		Deviation	Degree of reduction of deviation	T-test	
	M (After matching)	Processing group	Control group			T value	P value
Lev	U	0.536	0.46	42.5		11.18	0.000
	M	0.536	0.537	-0.3	98.8	-0.07	0.946
CFO	U	0.065	0.615	5.7		1.48	0.140
	M	0.065	0.066	-2.3	59.5	-0.49	0.627
Size	U	24.149	23.092	3.7		22.85	0.000
	M	24.149	24.087	-6.6	94.1	0.91	0.365
Incentives	U	15.068	14.699	53.6		14.99	0.000
	M	15.068	15.063	0.7	98.7	0.14	0.889
Mgtexpense	U	0.057	0.763	-42.3		-10.47	0.000
	M	0.057	0.056	-0.2	99.6	-0.04	0.972
Age	U	15.782	13.636	35.9		9.67	0.000
	M	15.782	15.735	0.8	97.8	0.16	0.871
Big10	U	65.299	57.264	48.8		13.92	0.000
	M	65.299	64.721	3.5	92.8	0.74	0.461
ROA	U	0.04	0.507	-18.7		-4.61	0.000
	M	0.04	0.041	-0.5	97.6	-0.09	0.925
Growth	U	0.113	0.181	-6.2		-1.30	0.192
	M	0.113	0.114	-0.1	98.9	-0.04	0.965