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Directors' and Officers' liability insurance and bond credit spreads: Evidence from China

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ABSTRACT

Using hand-collected data on purchases of D&O insurance by Chinese listed firms for the period from 2008 to 2019, we empirically find that D&O insurance negatively associates with credit spreads. The negative relationship still holds after conducting a series of robustness tests and is not driven by the eyeball effect. We also show that D&O insurance can reduce credit spreads via the channels of internal controls, external monitoring, information asymmetry and default risk. Moreover, the negative effect of D&O insurance on credit spreads is more pronounced for non-state-owned firms, those located in regions with a low level of marketization or that employ rating agencies with a bad reputation. Our study complements the literature on the credit spreads and corporate governance.

1. Introduction

Directors' and officers' liability insurance (hereinafter referred to as "D&O insurance"), also known as "the General's Helmet," is a kind of professional liability insurance. With the purchase of D&O insurance, directors, supervisors and senior management are protected from personal liability if they are accused by shareholders and other stakeholders (e.g., creditors) of wrongdoing or misconduct. The insurance company will cover the cost of defense as well as civil liability for directors, supervisors and senior management, depending on the contract. Since its introduction in the 1930s, D&O insurance has become increasingly popular among firms in developed economies, with a coverage rate of 96%, 90% and 86% in the U.S., Europe and Canada,

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respectively. As for Asia, 88% of Singapore firms are covered by D&O insurance, followed by a coverage rate of 85% in Hong Kong, China and 60% in Taiwan, China.[1]

The development of D&O insurance is still in its early stages in mainland China. Although D&O insurance has been available since 2002, only 10% of A-share listed firms had purchased D&O coverage by the end of 2019.[2] As the terms of the D&O contracts in the Chinese market are a direct translation of the terms in foreign contracts, firms find it costly to understand the policies, especially with regard to the boundary of the insurer's liability. Chinese investors' reluctance to bring lawsuits also lowers the probability of claims being triggered against D&O policies due to management misconduct. This explains why the first claim occurred in 2011, almost 10 years after the launch of D&O insurance in the Chinese market. This may lead to a biased perception of the costs and benefits associated with D&O coverage. Furthermore, firms may hesitate to propose the purchase of D&O insurance in shareholder meetings if the shareholders misunderstand D&O insurance as being part of management compensation. In summary, the high cost of information and misunderstandings about D&O insurance reduce a firm's willingness to purchase it.[3]

However, the purchase of D&O insurance increased sharply in 2020 following Luckin's claim against Ping An China and other insurance companies when Luckin faced class actions for financial fraud from multiple U. S. law firms.[4] Furthermore, the revised "Securities Law of the People's Republic of China" in 2020 further strengthens investor protections.[5] The law not only clarifies and regulates the behaviors, obligations and responsibilities of managements in disclosing information but also increases the penalties for violations. The increased risks that managers are now taking on in discharging their duties may further increase the demand for D&O coverage, making it necessary to investigate more closely the effect of D&O insurance in emerging markets.

Despite the popularity of D&O insurance in developed capital markets, studies of its economic consequences remain inconclusive. Some scholars emphasize the positive impact of D&O insurance in reducing management risk aversion and alleviating agency problems (Holderness, 1990; Romano, 1991; Core, 1997; O'Sullivan, 1997), factors that benefit the insured companies. The opposite view holds that the purchase of D&O insurance may cause or aggravate moral hazard due to the lower opportunity cost for management, which ultimately decreases the firm's value (Lin et al., 2011; Lin et al., 2013; Chen et al., 2016).

When studying corporate governance in emerging markets such as China, it is necessary to consider the peculiarities of the institutional environment. Due to the highly concentrated ownership structure of Chinese corporations, the conflicts of interest between controlling and minority shareholders are much more severe than those in developed economies (Jiang and Kim, 2020). The monitoring functions of the supervisory board and independent directors, as well as labor unions, are fatally compromised (Xiao et al., 2004; Liu, 2010; Tang et al., 2013), because they are subjected to the influence of block shareholders and must deal with ineffective board governance, leading to investors' urgent calls for improved corporate governance.

The purchase of D&O insurance gives the insurers a stake in the insured firm. This means that the insurer may be motivated to monitor corporate governance and control some of the risks of the insured firm to restrain opportunistic behavior by management and reduce agency costs (Holderness, 1990; O'Sullivan, 1997; Yuan et al., 2016). D&O insurance also protects senior management from personal liability, which helps to retain or attract management talent and encourages managers to act in the best interests of the enterprise (Priest, 1987; Wang et al., 2020). Accordingly, given China's special institutional context, by providing empirical evidence from the Chinese bond market, in this paper we investigate whether D&O insurance improves corporate governance.

[1] The data are collected from https://www.eastmoney.com/.

[2] The first D&O insurance in China was a joint policy written for Vanke Co., Ltd. by Ping An Insurance (Group) Company of China and Chubb Insurance Group in 2002. The first case of D&O insurance compensation was in 2011, when AIG compensated GAC Changfeng with the sum of 0.8 million Chinese yuan after civil lawsuits about GAC Changfeng's accounting misstatements.

[3] According to the Code of Corporate Governance for Listed Companies in China, the resolution to purchase D&O insurance must be voted on and approved by shareholder meeting before it can take effect.

[4] By the end of 2019, only about 400 A-share listed firms in the Chinese capital market were covered by D&O insurance. However, there were about 170 new purchases of D&O insurance in 2020, accounting for almost half of the total number in 2019.

[5] A series of items, including investor suitability management, derivatives litigation and some securities litigation, have been supplemented in the revised "Security Law of the People's Republic of China.".

The Chinese bond market is increasingly important for enterprise financing, given its fast and constant development, but it is immature. Since 2013, the "three–phase superposition" has increased the downward pressure on China's economy and the economic environment faced by Chinese enterprises has deteriorated.[6] Since Chaori Solar Co., Ltd. defaulted on its bonds in 2014, 184 companies had defaulted on a total of 576 bonds with a face value of 5.1 trillion Chinese yuan by the end of 2020. In particular, in late 2020 the consecutive defaults of Brilliance Group followed by Yongmei Holdings seriously undermined investor confidence, leading to an increase in the risk premiums of corporate bonds.[7] Therefore, reducing the cost of debt financing is not only an urgent issue at the corporate level but also the key to preventing or resolving systemic financial risk and promoting steady economic development in China.

Studies use bond credit spreads as a measure of risk and identify reductions in credit spreads to gauge the effectiveness of corporate governance in protecting investors' interests (Bhojraj and Sengupta, 2003; Anderson et al., 2004; Tang et al., 2015; Gao et al., 2020). We therefore investigate whether bond market investors perceive D&O insurance coverage as an effective governance mechanism by examining the relationship between the purchase of D&O insurance and bond credit spreads. Using hand-collected data on the D&O insurance coverage of Chinese listed firms for the period from 2008 to 2019, we document how the purchase of D&O insurance is associated with narrower credit spreads. This negative association still holds after a series of robustness tests, including instrumentation, the Heckman two-stage procedure, propensity score matching (PSM), a placebo test, the use of alternative variables as well as several fixed effects models. Further analysis illustrates that the purchase of D&O insurance can reduce credit spreads via the channels of internal controls, external monitoring, information asymmetry and default risk. In addition, the negative impact of D&O insurance on credit spreads is more pronounced for non-state-owned enterprises (non-SOEs), firms that are located in regions with a low level of marketization or firms that employ rating agencies with a bad reputation. We also verify that the negative relationship is not driven by the eyeball effect.

Our study contributes to the literature in several ways. First, this study supplements the literature on the determinants of bond credit spreads. The literature not only identifies how external factors, such as the macroeconomic environment (Longstaff and Schwartz, 1995), analyst forecasts (Mansi et al., 2011) and media coverage (Gao et al., 2020) affect credit spreads, but also recognize the impacts of internal factors, including board structure (Anderson et al., 2004), personal traits of managers (Ma et al., 2021), internal controls (Tang et al., 2015) and leveraged buyouts (Eisenthal-Berkovitz et al., 2020). Our study examines how the purchase of D&O insurance affects credit spreads and further expands the literature on the determinants of bond credit spreads.

Second, our study enriches the literature that examine the economic consequences of D&O insurance. The literature investigates the impact of D&O insurance on M&A (Lin et al., 2011), diversification (Chi et al., 2013), investment efficiency (Li & Liao, 2014), audit pricing (Chung et al., 2015), the sensitivity of executive compensation to performance (Wang and Chen, 2016), loan spreads (Lin et al., 2013), the cost of equity (Chen et al., 2016), stock price crash risk (Yuan et al., 2016) and firm innovation (Wang et al., 2020). This study complements the literature by exploring how D&O insurance affects corporate bond credit spreads.

Third, our study enhances the understanding of D&O insurance as an effective governance mechanism by providing new evidence from an emerging market. The majority of the literature based on the situation in developed economies illustrates how D&O insurance negatively affects firm value through overinvestment, empire building behavior, lower post-acquisition performance, financial restatements and other opportunistic behaviors (Lin et al., 2011; Chi et al., 2013; Li and Liao, 2014; Weng et al., 2017). It is not clear how bond investors perceive D&O insurance when deciding credit spreads. Given the significant differences in both institutional contexts and D&O insurance coverage between China and developed countries (Jiang and Kim, 2020), it is necessary to explore how D&O insurance affects the corporate governance of Chinese firms. Our empirical study suggests that the purchase of D&O insurance can lower the cost of debt financing via the channels of internal governance, external supervision, information asymmetry and default risk.

[6] The "three–phase superposition" refers to the overlap of 3 phases including shift of economic growth, structural adjustment and the pre-stimulus digestion.

[7] The coupon rate of the "20 liantai 01" note issued by Guangdong liantai Group Co., Ltd. reached 6.5%, while the coupon rate of the "20 Jinhui 03" bond issued by Jinhui Group Co., Ltd. reached 6.95%.

The remainder of this study is organized as follows. Section 2 reviews relevant studies in the literature on D&O insurance and credit spreads. Section 3 develops our contrasting hypotheses. Section 4 describes the research methodology, variable definitions, and data. Section 5 presents the empirical results and explanations. Sections 6 to 8 provide robustness tests, channel analysis and further analysis, respectively. Section 9 concludes the paper.

2. Literature review

We explore the impact of D&O insurance on bond credit spreads from the perspective of corporate governance. The literature on the economic consequences of D&O insurance and the factors that influence credit spreads is reviewed, and contrasting hypotheses are developed accordingly.

Studies of the relationship between D&O insurance and corporate governance remain inconclusive. The main points are as follows. First, the purchase of D&O insurance may reduce managers' risk aversion by effectively transferring risk when making decisions (Romano, 1991; Core, 1997) and shielding managers from legal liability for wrongdoing when discharging their duties. This helps to attract or retain management talent (Priest, 1987) and encourages managers to dedicate themselves to innovation or some other activity that increases firm value. Second, the purchase of D&O insurance introduces insurers as external monitors of the insured firm, which restrains managerial opportunism and alleviates the agency conflicts between shareholders and management (Holderness, 1990; O'Sullivan, 1997). The literature shows that firms with D&O insurance coverage have more conservative earnings (Liao et al., 2016), better information disclosure (Li and Liao, 2014) and lower stock price crash risk (Yuan et al., 2016). However, the opposite view argues that D&O insurance may cause unintended moral hazard. D&O insurance protects management from litigation liability, weakens the deterrent effect of the law on managers and induces managerial opportunism. The literature based on developed capital markets indicates that D&O insurance coverage leads to higher M&A premiums, lower M&A synergy (Lin et al., 2011), reduced investment efficiency (Li and Liao, 2014), more empire building behavior through unrelated diversification (Chi et al., 2013), more financial restatements (Weng et al., 2017) and increases in the cost of debt and equity financing (Lin et al., 2013; Chen et al., 2016).

Credit risk significantly affects firms' cost of debt financing (Fisher, 1959) and is reflected in bond credit spreads. The literature explores both the internal and external factors that affect credit spreads. First, the macroeconomic environment systematically affects bond credit risk (Longstaff and Schwartz, 1995). For instance, an economic boom narrows the credit spread while uncertainty in economic policy significantly broadens it (Guha and Hiris, 2002). Second, the stakeholders, including analysts, institutional investors, banks, the media and labor unions, can influence credit spreads (Chen et al., 2011; Mansi et al., 2011; Cai et al., 2019; Ma et al., 2019; Gao et al., 2020). Third, firms' operating activities, such as innovation (Hsu et al., 2015), corporate social responsibility (CSR) disclosure (Gong et al., 2018) and the use of financial derivatives to hedge risk (Chen and King, 2014), can tighten credit spreads. Finally, studies investigating the impacts of ownership structure (Anderson et al., 2003), board structure (Anderson et al., 2004), internal controls (Tang et al., 2015), managerial characteristics (Ma et al., 2021) and Party organizations (Tong et al., 2021) attribute the decrease in bond credit risk to reduced information asymmetry via better corporate governance (Bhojraj and Sengupta, 2003).

In summary, studies demonstrate how to reduce credit spreads by improving corporate governance, whereas little is known about the effect of D&O insurance on bond spreads in the context of the Chinese institutional background. Therefore, we fill this gap by investigating how the purchase of D&O insurance affects corporate bond credit spreads.

3. Hypothesis development

The literature on the economic consequences of D&O insurance shows that there are conflicting views on how the purchase of D&O insurance affects bond credit spreads.

One view is that D&O insurance can reduce credit spreads through improved internal governance and enhanced external monitoring. First, D&O insurance covers management against legal liability as long as

the executives perform their duties in the best interest of the firm. Such protection may attract talent with advanced management skills, which then strengthens the effectiveness and efficiency of internal governance (Priest, 1987). In addition, managers' risk tolerance will change to accept high-risk but valuable projects (Wang et al., 2008; Hwang and Kim, 2018), which in turn increases firm value, improves competitiveness and decreases bond default risk (Hsu et al., 2015). Second, D&O insurance introduces the insurer as an external supervisor, which restrains managerial opportunism and decreases agency costs (Holderness, 1990; O'Sullivan, 1997). D&O insurance works on a claims basis, which means that the insurer is obliged to cover the claims of a third party during the period of validity of the policy, even when the event leading to the litigation happens before the effective date of the policy. Therefore, insurance companies will carefully assess the overall riskiness of clients and conduct due diligence on executives before underwriting the policy. They may also reduce managerial opportunism through pricing and by drawing up specific clauses in the contract (Core, 1997). During the underwriting period, the insurer may continuously monitor both operations and managers' behaviors and prevent management from pursuing individual interests at the expense of the firm to reduce the risk of litigation by shareholders (Yuan et al., 2016). Third, management may improve information transparency to receive positive feedback from insurers and cut insurance premiums. Given the negative impact of information asymmetry on the cost of debt financing, the reduction of information asymmetry brought about by D&O insurance may lower the risk premium required by bond investors (Yu, 2005; Park and Wu, 2009). Finally, D&O insurance functions as risk control. D&O insurance is a component of liquidation assets if a firm files for bankruptcy, which lowers the probability of bond default and the cost of debt financing (Core, 1997; Zou and Adams, 2008).

The opposite view claims that the purchase of D&O insurance transfers potential litigation risk to the insurer and may induce more opportunism, thus increasing bond credit spreads. First, the purchase of D&O insurance may encourage aggressive financial policies, leading to more financial restatements (Weng et al., 2017), less conservative accounting (Chung and Wynn, 2008) and poorer information disclosure. In addition, the purchase of D&O insurance may encourage managers to behave irrationally (Chalmers et al., 2002), such as by overinvesting (Li and Liao, 2014), by paying higher M&A premiums (Lin et al., 2011) and by engaging in empire building behavior (Lin et al., 2011), all of which negatively affect firm value (Aguir and Aguir, 2020). Accordingly, bond investors will require higher risk premiums.

Therefore, we propose contrasting hypotheses regarding the impact of D&O insurance on bond credit spreads:

H1a: Ceteris paribus, the purchase of D&O insurance is negatively associated with bond credit spreads.
H1b: Ceteris paribus, the purchase of D&O insurance is positively associated with bond credit spreads.

4. Research design

4.1. Sample data

Our sample consists of corporate bonds and medium-term notes issued on the exchange or interbank market by companies listed on the Shanghai Stock Exchange and the Shenzhen Stock Exchange from 2008 to 2019. We choose 2008 as the beginning year of our sample for two reasons. First, the issuance of corporate bonds was initiated in late 2007. Second, the issuance of medium-term notes started after April 2008.

We manually collect D&O insurance coverage data from firms' annual reports and documents such as announcements by the board of directors and from shareholder meetings. The data on bond issuance are available from Wind and the data on corporate finance and governance are obtained from the China Stock Market and Accounting Research (CSMAR) database.

The sample construction process is as follows. First, we exclude financial firms as their reporting rules and capital structures differ from those of other companies. Second, we exclude floating-rate bonds as we cannot obtain the credit spread. We also exclude callable bonds given the uncertain influence of the embedded redemption option. After dropping observations with missing financial data or information on corporate governance, our sample consists of 7,783 bond-year observations, representing 2,301 bonds issued by 726 firms

during the sample period. As shown in Fig. 1, 40.36% of the firms in the sample (that is, 293 out of 726 firms) issue only one bond while 0.69% of the firms (that is, five firms) issue more than 20 bonds.

4.2. Models

We construct the following model to empirically investigate the effect of D&O insurance on bond credit spreads.

$$CS_{i,t} = \beta_0 + \beta_1 Doins_{i,t} + \sum_{q=2}^{m} \beta_q (ControlVariable_{i,t}) + \delta_j + \tau_t + \varepsilon_{i,t} \quad (1)$$

The subscripts i and t stand for bond and year, respectively. β_1 represents regression the coefficient of interest and $\varepsilon_{i,t}$ is the error term. Our dependent variable $CS_{i,t}$ measures the credit spread. $Doins_{i,t}$ represents D&O insurance coverage. A negative (positive) β_1 suggests that D&O insurance leads to a decrease (increase) in the credit spread.

Three sets of controls are used in our model. The first set relates to the financial data of the sample firms, including firm size ($Size_{i,t}$), financial leverage ($Lev_{i,t}$), profitability ($ROA_{i,t}$), firm growth ($Growth_{i,t}$), operating cash flow ($CF_{i,t}$) and value of mortgaged assets ($Tang_{i,t}$). The second set controls for variations in corporate governance, including board size ($Board_{i,t}$), board independence ($Independent_{i,t}$) and CEO–chairman duality ($Dual_{i,t}$). The last set of controls refers to bond characteristics, including bond size ($BondSize_{i,t}$), bond maturity ($BondTerm_{i,t}$), the existence of collateral ($BondSecured_{i,t}$), put option embedding ($BondPut_{i,t}$) and bond credit ratings ($BondCredit_{i,t}$). Furthermore, we control for year fixed effects (τ_t) and industry fixed effects (δ_j) during the sample period. Appendix I summarizes the definitions of all of the variables used in our model.

4.3. Variable definitions

4.3.1. Explained variable: Bond credit spread

Following prior studies (Yu, 2005; Jiang, 2008; Chen et al., 2011; Byun et al., 2013; Gao et al., 2019), we define a bond credit spread ($CS_{i,t}$) as the difference in yield to maturity (YTM) between a corporate bond and the treasury bond with the closest maturity date. The yields of treasury bonds are obtained from the standard term information of the treasury bond yield curve published on ChinaBond.com.cn. Linear interpolation is used to calculate maturity if there is no close maturity match between treasury bonds and corporate bonds. In addition, we use alternative measures of bond credit spreads in robustness tests.

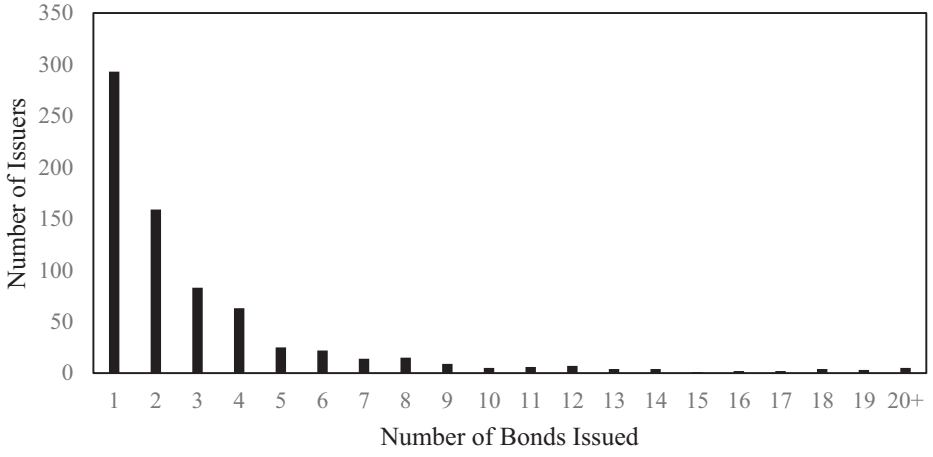

Fig. 1. Distribution of the number of bonds issued.

4.3.2. Explanatory variable: D&O insurance

The literature adopts two sets of D&O insurance measures (Lin et al., 2013; Chen et al., 2016). For continuous measurement, the intensity of D&O insurance coverage (the protection level of D&O insurance) is calculated using data on D&O insurance premiums (coverage). However, it is generally difficult to obtain this information given its lack of mandatory disclosure in the Chinese capital market. Following Jia et al. (2019), Yuan et al. (2016) and Zou et al. (2008), we adopt the dummy variable $Doins_{i,t}$ to measure D&O insurance, which equals 1 if a listed firm purchases D&O insurance and 0 otherwise.

4.3.3. Control variables

Drawing on the literature (Anderson et al., 2004; Gao et al., 2020; Tong et al., 2021), we use several sets of variables that affect bond credit spreads.

The first set relates to firms' financial characteristics. Large firms are usually associated with tighter bond credit spreads (Chen and King, 2014; Gao et al., 2020). Thus, we include the logarithm of total assets ($Size_{i,t}$) in the model. Chen and King (2014) and Gao et al. (2020) show that financial leverage is associated with wider bond credit spreads. We thus adopt the variable $Lev_{i,t}$, measured as total liabilities over total assets, to control for these effects. Given that greater profitability acts to tighten bond credit spreads (Chakravarty and Rutherford, 2017), we include $ROA_{i,t}$ as a control. Firm growth is also an important factor affecting bond credit spreads (Mansi et al., 2011; Jia et al., 2019; Tong et al., 2021); accordingly, we control for the operating revenue growth rate ($Growth_{i,t}$) in our model. Following Byun et al. (2013), we control for the impacts of operating cash flow ($CF_{i,t}$) and the value of mortgaged assets ($Tang_{i,t}$).

We adopt multiple corporate governance factors as the second set of controls. Among them, $Board_{i,t}$ is the natural logarithm of the total number of board members, $Independent_{i,t}$ is measured by the percentage of independent directors over the total number of board members. We also take into account the effect of CEO–chairmanCEO duality with the dummy variable $Dual_{i,t}$.

Moreover, we control for bond features. We measure bond size ($BondSize_{i,t}$) as the natural logarithm of the total issuance amount. Bond maturity ($BondTerm_{i,t}$) is measured as the natural logarithm of bond maturity at the observation point. $BondSecured_{i,t}$ is a dummy variable to control for the difference when a bond is secured with collateral. We also use the dummy variable $BondPut_{i,t}$ to control for the effect of put options embedded in bonds. The last bond feature is the credit rating. We construct the ordered variable $BondCredit_{i,t}$ by assigning values to different ratings. Specifically, $BondCredit_{i,t}$ equals 5 for AAA ratings, 4 for AA + ratings, 3 for AA ratings, 2 for AA- ratings and 1 for A + ratings. Detailed definitions of the variables can be found in Appendix I. To eliminate the effects of extreme values, we winsorize all continuous variables at the 1% and 99% levels.

5. Empirical results and discussion

5.1. Descriptive statistics

As shown in Panel A of Table 1, D&O insurance coverage increases continuously year on year. In Panel B, we report the distribution of D&O insurance coverage by industry. About 40.85% of the firms in the transportation, storage and postal industries purchase D&O insurance, followed by the mining sector with a coverage rate of 38.10%. Panel C of Table 1 provides descriptive statistics for the variables used in this study. $CS_{i,t}$ ranges from 0.2149% to 5.5162% and the average value is 2.2186%. The standard deviation of 1.4036% indicates a large variation in the credit risk of corporate bonds. Only about 19.77% of the firms in the sample have D&O insurance, illustrating the large differences in D&O coverage between China and developed economies. As for corporate finance controls, the average firm size is 24.3731, financial leverage is 60.97%, ROA is 2.89%, sales growth is 15.22% and operating cash flow is 4.5% of total assets. The average percentage of tangible assets is 44.61%. As for the boards of directors, the average board size is 2.2194, 38% of which are independent directors, while 82.06% of the firms have no CEO–chairman duality issue. With regard to bond features, the average issuance amount is 2.2814 with an average maturity of 0.7234. In addition, 30% of the bonds are issued with collateral and 45% have put options embedded. The average value of the credit rating is 3.9372. In Panel D, we report the results of the univariate analysis for the explained and control variables. The mean (median) of $CS_{i,t}$ is 1.5609 (1.3613) for insured firms and 2.3807 (2.0880) for firms without D&O

Table 1
Sample distribution and descriptive statistics.

Year	Insured firms ($Doins_{i,t} = 1$)	Uninsured firms ($Doins_{i,t} = 0$)	Total observations
Panel A: Sample Distribution by Year			
2008	12	39	51
2009	23	91	114
2010	30	133	163
2011	49	229	278
2012	86	389	475
2013	103	503	606
2014	109	560	669
2015	136	704	840
2016	195	927	1,122
2017	203	923	1,126
2018	256	923	1,179
2019	337	823	1,160
Total	1,539	6,244	7,783
Panel B: Sample Distribution by Industry			
Agriculture, forestry, animal husbandry and fishery	0	48	48
Mining	224	364	588
Manufacturing	452	2,495	2,947
Electricity, heat, gas and water production and supply	183	553	736
Construction	75	463	538
Wholesale and retail	53	314	367
Transport, warehousing and postal services	279	404	683
Accommodation and catering	0	6	6
Information transmission, software and information technology services	7	123	130
Real Estate	257	1,119	1,376
Leasing and business services	0	120	120
Scientific research and technology services	0	9	9
Water, environment and public facilities management	5	88	93
Residential services, repairs and other services	0	1	1
Health and social work	0	13	13
Culture, sports and entertainment industry	0	65	65
Comprehensive	4	59	63
Total	1,539	6,244	7,783

Panel C: Descriptive Statistics

Variable	Obs.	Mean	Std. Dev.	Min.	P25	Median	P75	Max.
$CS_{i,t}$	7,783	2.2186	1.4036	0.2149	1.1853	1.9014	2.9887	5.5162
$Doins_{i,t}$	7,783	0.1977	0.3983	0.0000	0.0000	0.0000	0.0000	1.0000
$Size_{i,t}$	7,783	24.3731	1.5459	21.4402	23.1731	24.1587	25.4866	28.4820
$Lev_{i,t}$	7,783	0.6097	0.1540	0.2124	0.5024	0.6222	0.7308	0.8821
$ROA_{i,t}$	7,783	0.0289	0.0326	−0.1030	0.0131	0.0257	0.0432	0.1281
$Growth_{i,t}$	7,783	0.1522	0.2987	−0.4673	−0.0077	0.1048	0.2632	1.5114
$CF_{i,t}$	7,783	0.0450	0.0606	−0.1350	0.0115	0.0464	0.0824	0.1925
$Tang_{i,t}$	7,783	0.4461	0.1878	0.0431	0.3165	0.4456	0.5989	0.8349
$Board_{i,t}$	7,783	2.2194	0.2205	1.6094	2.0794	2.1972	2.3979	2.7081
$Independent_{i,t}$	7,783	0.3805	0.0645	0.3077	0.3333	0.3636	0.4286	0.6250
$Dual_{i,t}$	7,783	0.8206	0.3837	0.0000	1.0000	1.0000	1.0000	1.0000
$BondSize_{i,t}$	7,783	2.2814	0.8890	0.0000	1.6094	2.3026	2.8904	4.7005
$BondTerm_{i,t}$	7,783	0.7234	0.8822	−2.3167	0.3167	0.9102	1.3479	2.2407
$BondSecured_{i,t}$	7,783	0.2973	0.4571	0.0000	0.0000	0.0000	1.0000	1.0000
$BondPut_{i,t}$	7,783	0.4510	0.4976	0.0000	0.0000	0.0000	1.0000	1.0000
$BondCredit_{i,t}$	7,783	3.9372	1.0211	1.0000	3.0000	4.0000	5.0000	5.0000

Panel D: Univariate Analysis

Variable	Insured firms ($Doins_{i,t}=1$)			Uninsured firms ($Doins_{i,t}=0$)			t-value	chi^2 statistic
	Obs.	Mean	Median	Obs.	Mean	Median		
$CS_{i,t}$	1,539	1.5609	1.3613	6,244	2.3807	2.0880	−21.0993***	420.8020***
$Size_{i,t}$	1,539	25.4815	25.6209	6,244	24.0998	23.8810	33.6051***	687.3078***
$Lev_{i,t}$	1,539	0.6324	0.6588	6,244	0.6042	0.6156	6.4549***	30.2308***
$ROA_{i,t}$	1,539	0.0277	0.0250	6,244	0.0292	0.0261	−1.607	2.7629*
$Growth_{i,t}$	1,539	0.1229	0.1008	6,244	0.1594	0.1074	−4.3021***	1.744
$CF_{i,t}$	1,539	0.0578	0.0606	6,244	0.0418	0.0423	9.3626***	109.9127***
$Tang_{i,t}$	1,539	0.4562	0.4879	6,244	0.4436	0.4395	2.3645**	23.1865***
$Board_{i,t}$	1,539	2.2597	2.1972	6,244	2.2094	2.1972	8.0467***	133.7923***
$Independent_{i,t}$	1,539	0.3892	0.3636	6,244	0.3783	0.3636	5.9327***	24.2437***
$Dual_{i,t}$	1,539	0.9019	1.0000	6,244	0.8006	1.0000	9.3260***	.
$BondSize_{i,t}$	1,539	2.8059	2.7081	6,244	2.1521	2.1401	27.0253***	506.4293***
$BondTerm_{i,t}$	1,539	0.8335	0.9774	6,244	0.6963	0.8857	5.4767***	22.1031***
$BondSecured_{i,t}$	1,539	0.2619	0.0000	6,244	0.3061	0.0000	−3.3996***	11.5434***
$BondPut_{i,t}$	1,539	0.3093	0.0000	6,244	0.4859	0.0000	−12.5968***	155.5473***
$BondCredit_{i,t}$	1,539	4.5517	5.0000	6,244	3.7857	4.0000	27.6167***	762.7968***

Note: ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

insurance coverage. The difference is statistically significant at the 1% level, implying that insured firms have lower credit spreads than uninsured firms. In addition, significant differences exist among the control variables between the two groups.

5.2. Correlation matrix

Table 2 presents the correlation matrix across all variables, with the Pearson correlation shown in the bottom left and the Spearman correlation shown in the upper right. The results show that $Doins_{i,t}$ is significantly and negatively associated with $CS_{i,t}$. The correlation coefficients between the control variables are less than 0.8. We calculate the variance inflation factor (VIF) to further test the multicollinearity issue. The largest VIF is 3.35, well below the threshold value of 10. Thus, multicollinearity is unlikely to be a serious issue in our study.

5.3. Multivariate analysis

Table 3 presents the results of the baseline regression. Column (1) only includes the variable of interest and controls for year and industry fixed effects. In column (2), firm characteristics are added to the model. In column (3), we further control for the effects of bond features. The coefficients of $Doins_{i,t}$ in all columns are negatively associated with $CS_{i,t}$ and significant at the 1% level, thereby supporting H1a. The coefficient of $Doins_{i,t}$ in column (3) is −0.2977, illustrating a 29.77 basis point decrease in credit spreads for insured firms compared with uninsured firms. Given that the average bond credit spread is 2.22%, purchasing D&O insurance helps reduce the credit spread by 13.41%. In summary, purchasing D&O insurance benefits insured firms with strong external monitoring, by improving information transparency, reducing default risk and lowering credit spreads.

The coefficients for the control variables are generally consistent with prior studies (Gao et al., 2020; Tong et al., 2021). Firms with more assets, lower leverage, better profitability, lower growth, a higher value of mortgage assets, larger board size and greater board independence, separation of the roles of chairman and CEO, a larger bond issuance amount, longer bond maturity, higher bond credit ratings and no security clauses or put options embedded in their bonds are associated with tighter credit spreads.

Table 2
Correlation coefficient matrix.

Variable	$CS_{i,t}$	$Doins_{i,t}$	$Size_{i,t}$	$Lev_{i,t}$	$ROA_{i,t}$	$Growth_{i,t}$	$CF_{i,t}$	$Tang_{i,t}$	$Board_{i,t}$	$Independent_{i,t}$	$Dual_{i,t}$	$BondSize_{i,t}$	$BondTerm_{i,t}$	$BondSecured_{i,t}$	$BondPut_{i,t}$	$BondCredit_{i,t}$
$CS_{i,t}$	1	**−0.2490*****	−0.3228***	0.1117***	−0.2127***	−0.0059	−0.1882***	−0.0302***	−0.1268***	−0.0647***	−0.1368***	−0.3043***	−0.0867***	0.0344***	0.1764***	−0.4698***
$Doins_{i,t}$	**−0.2326*****	1	0.3482***	0.0675***	−0.0116	−0.0306***	0.1233***	0.0356***	0.0938***	0.0810***	0.1051***	0.2889***	0.0662***	−0.0385***	−0.1414***	0.3211***
$Size_{i,t}$	−0.2888***	0.3560***	1	0.4629***	−0.0219*	0.0897***	0.0673***	0.2386***	0.1975***	0.1408***	0.0329***	0.7026***	0.0702***	−0.1458***	−0.2388***	0.5772***
$Lev_{i,t}$	0.1313***	0.0730***	0.4157***	1	−0.4323***	0.0897***	−0.2655***	0.2939***	0.0183	0.0682***	−0.0293***	0.2351***	−0.0088	−0.0575***	−0.0079	0.0252**
$ROA_{i,t}$	−0.2257***	−0.0182	0.0043	−0.4213***	1	0.2363***	0.2994***	−0.1441***	0.0627***	−0.0635***	0.0322***	−0.0016	0.0355***	−0.0787***	−0.0406***	0.0986***
$Growth_{i,t}$	0.0217*	−0.0487***	0.0385***	0.0678***	0.1967***	1	0.0009	0.0135	−0.0055	−0.0001	−0.0536***	−0.0038	0.0093	−0.0449***	0.0523***	−0.0417***
$CF_{i,t}$	−0.1639***	0.1055***	0.0922***	−0.2521***	0.3127***	−0.0010	1	0.1323***	0.1836***	−0.0385***	0.0719***	0.1213***	0.0232**	0.0254**	−0.1309***	0.1630***
$Tang_{i,t}$	−0.0285**	0.0268**	0.2163***	0.2856***	−0.1107***	0.0047	0.1062***	1	0.1357***	−0.0757***	0.0654***	0.2260***	0.0801***	0.0447***	−0.0514***	0.0599***
$Board_{i,t}$	−0.1392***	0.0908***	0.2106***	0.0271**	0.0711***	−0.0212*	0.1721***	0.1401***	1	−0.4110***	0.1441***	0.1629***	0.0893***	−0.0187*	−0.1441***	0.1701***
$Independent_{i,t}$	−0.0808***	0.0671***	0.1843***	0.1053***	−0.0778***	−0.0105	−0.0552***	−0.0676***	−0.4449***	1	−0.1053***	0.1028***	0.0097	0.0266**	−0.0857***	0.1094***
$Dual_{i,t}$	−0.1511***	0.1051***	0.0341***	−0.0323***	0.0212*	−0.0549***	0.0725***	0.0623***	0.1506***	−0.1204***	1	0.0541***	0.0689***	0.0630***	−0.1053***	0.1312***
$BondSize_{i,t}$	−0.2902***	0.2929***	0.7018***	0.1996***	0.0230**	−0.0349***	0.1357***	0.2116***	0.1858***	0.1223***	0.0611***	1	0.1699***	0.0036	−0.1413***	0.5085***
$BondTerm_{i,t}$	−0.1333***	0.0620***	0.0793***	0.0055	0.0461***	0.0092	0.0075	0.0830***	0.0909***	0.0109	0.0540***	0.1555***	1	0.1445***	0.0711***	0.2381***
$BondSecured_{i,t}$	0.0278**	−0.0385***	−0.1319***	−0.0570***	−0.0654***	−0.0107	0.0179	0.0521***	−0.0085	0.0303***	0.0630***	0.0019	0.1191***	1	0.0437***	0.1805***
$BondPut_{i,t}$	0.1954***	−0.1414***	−0.2430***	−0.0095	−0.0485***	0.0618***	−0.1285***	−0.0511***	−0.1546***	−0.0856***	−0.1053***	−0.1542***	0.0500***	0.0437***	1	−0.2493***
$BondCredit_{i,t}$	−0.4413***	0.2988***	0.5281***	0.0080	0.0817***	−0.0804***	0.1468***	0.0547***	0.1787***	0.1272***	0.1241***	0.4737***	0.2323***	0.1645***	−0.2411***	1

Note: Lower triangular cells report Pearson's correlation coefficients, upper triangular cells are Spearman's rank correlation coefficients. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 3
The impact of D&O insurance on bond credit spreads.

Variable	(1)	(2)	(3)
$Doins_{i,t}$	−0.6774***	−0.3772***	−0.2977***
	(−20.65)	(−11.16)	(−9.15)
$Size_{i,t}$		−0.2905***	−0.0732***
		(–23.26)	(−4.22)
$Lev_{i,t}$		1.8434***	1.2918***
		(13.22)	(9.49)
$ROA_{i,t}$		−6.4890***	−6.0767***
		(−11.42)	(−11.01)
$Growth_{i,t}$		0.2154***	0.1005*
		(3.94)	(1.91)
$CF_{i,t}$		0.4598	0.2308
		(1.59)	(0.84)
$Tang_{i,t}$		−0.1374*	−0.1671**
		(−1.67)	(−2.10)
$Board_{i,t}$		−0.3187***	−0.2380***
		(−4.39)	(−3.43)
$Independent_{i,t}$		−1.9361***	−1.4421***
		(−7.47)	(−5.61)
$Dual_{i,t}$		−0.3534***	−0.2835***
		(−8.69)	(−7.21)
$BondSize_{i,t}$			−0.0849***
			(−3.68)
$BondTerm_{i,t}$			−0.0420**
			(−2.24)
$BondSecured_{i,t}$			0.2225***
			(7.18)
$BondPut_{i,t}$			0.1137***
			(3.88)
$BondCredit_{i,t}$			−0.4401***
			(−21.58)
Constant	3.2349***	11.2788***	7.7764***
	(14.76)	(31.93)	(19.45)
Year fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Observations	7,783	7,783	7,783
Adjusted R^2	0.1793	0.3064	0.3688

Note: The t-statistics are reported in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

6. Robustness tests

In this section, we conduct several robustness tests to confirm the reliability of our results, including the instrumental variable (IV) approach, the Heckman two-stage procedure, PSM, entropy balance (EB), a placebo test, the use of alternative explained (explanatory) variables and alternative models.

6.1. Endogeneity issues

The results of our baseline regression confirm that the purchase of D&O insurance can effectively decrease bond credit spreads. However, such results may not be robust due to endogeneity issues. For instance, insurance companies are more likely to choose clients with low default risk. We therefore use three methods to address endogeneity concerns.

Table 4
IV regression analysis of the impact of D&O insurance on bond credit spreads.

Variable	First-stage regression $Doins_{i,t}$	Second-stage regressions $CS_{i,t}$		
		2SLS	GMM	LIML
$IndustryMean_{i,t}$	0.1423***			
	(14.52)			
$OverseaBack_{i,t}$	0.3474***			
	(4.20)			
$Doins_{i,t}$		−0.7926***	−0.7901***	−0.7929***
		(−4.25)	(−4.24)	(−4.25)
$Size_{i,t}$	0.0707***	−0.0337	−0.0336	−0.0337
	(12.82)	(−1.49)	(−1.48)	(−1.49)
$Lev_{i,t}$	0.1109***	1.3217***	1.3228***	1.3217***
	(3.09)	(9.55)	(9.56)	(9.55)
$ROA_{i,t}$	−0.4802***	−6.3859***	−6.3852***	−6.3861***
	(−3.31)	(−11.19)	(−11.19)	(−11.19)
$Growth_{i,t}$	−0.0314**	0.0883*	0.0882*	0.0883*
	(−2.32)	(1.65)	(1.65)	(1.65)
$CF_{i,t}$	0.1980***	0.3444	0.3424	0.3444
	(2.66)	(1.22)	(1.21)	(1.22)
$Tang_{i,t}$	−0.1626***	−0.2566***	−0.2566***	−0.2567***
	(−6.16)	(−2.92)	(−2.92)	(−2.92)
$Board_{i,t}$	−0.0714***	−0.2690***	−0.2686***	−0.2690***
	(−3.19)	(−3.79)	(−3.79)	(−3.79)
$Independent_{i,t}$	0.1057	−1.3964***	−1.3984***	−1.3964***
	(1.49)	(−5.38)	(−5.39)	(−5.38)
$Dual_{i,t}$	0.0822***	−0.2446***	−0.2444***	−0.2446***
	(8.93)	(−5.89)	(−5.88)	(−5.89)
$BondSize_{i,t}$	0.0150**	−0.0753***	−0.0755***	−0.0753***
	(2.08)	(−3.18)	(−3.19)	(−3.18)
$BondTerm_{i,t}$	0.0122**	−0.0346*	−0.0348*	−0.0346*
	(2.32)	(−1.82)	(−1.83)	(−1.82)
$BondSecured_{i,t}$	−0.0028	0.2176***	0.2179***	0.2176***
	(−0.29)	(6.85)	(6.86)	(6.85)
$BondPut_{i,t}$	−0.0245***	0.1009***	0.1012***	0.1009***
	(−2.72)	(3.38)	(3.39)	(3.38)
$BondCredit_{i,t}$	0.0224***	−0.4248***	−0.4250***	−0.4247***
	(4.16)	(−19.86)	(−19.87)	(−19.86)
Constant	−1.6724***	6.7377***	6.7394***	6.7371***
	(−12.41)	(12.56)	(12.57)	(12.56)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	7,758	7,758	7,758	7,758
Pseudo R^2/Adjusted R^2	0.2263	0.3510	0.3512	0.3510
F	118.78			
Sargan		0.1966	0.1966	0.1574
(P-value)		(0.6575)	(0.6575)	(0.6916)

Note: The t-statistics are reported in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

6.1.1. IV approach

Our baseline results show that the purchase of D&O insurance helps tighten bond credit spreads. However, it could be argued that firms with higher credit risk are more inclined to purchase D&O insurance to attract more investors and lower the cost of debt. We implement the IV approach to mitigate endogeneity issues caused by reverse causality. Following the literature (Lin et al., 2011), we construct $IndustryMean_{i,t}$ (the mean of industry D&O insurance coverage for firms in the same year excluding the focal firm) as the first IV for a firm's purchase of D&O insurance for two reasons. First, to attract talented managers, enterprises may imitate competitors' purchase of D&O insurance. Second, firms in the same industry share similarities in economic

cycle, operational risk and litigation risk from shareholders. Therefore, industry D&O insurance coverage may affect an individual firm's intention to purchase D&O insurance but not directly influence its default risk. We use the existence of independent directors with overseas work experience ($OverseaBack_{i,t}$) as the second IV. Given the prevalence of D&O insurance in overseas capital markets, independent directors with overseas work experience may better recognize potential risk while carrying out their duties, so they may decide to purchase D&O insurance to cover their potential litigation liability (Giannetti et al., 2015). Such work experience does not directly affect firms' default risk, thus meeting the requirements of relevance and exogeneity for IVs.

Three IV techniques are used, including two-stage least squares (2LSL), the generalized method of moments (GMM) and limited information maximum likelihood (LIML). The first-stage regression results in Table 4 show that both $IndustryMean_{i,t}$ and $OverseaBack_{i,t}$ are positively associated with the purchase of D&O insurance at the 1% significance level. With respect to IV validity, the weak instrument F-test of 118.78 is much larger than 10 and meets the relevance requirements. Additionally, the nonsignificant Sargan value of the overidentification test illustrates that our IVs are not correlated with the error terms, indicating that they will not affect credit spreads by means other than D&O insurance.

The coefficients of $Doins_{i,t}$ in the second-stage regression are statistically negative and significant at the 1% level among the three IV regression models. This further supports H1a that D&O insurance negatively affects credit spreads after addressing endogeneity issues.[8]

6.1.2. The Heckman two-stage model

Our study uses a sample consisting of enterprises' bonds and medium-term notes. However, there could be obvious differences between firms that have issued bonds and those that have not yet done so. For example, research finds that large firms prefer bond financing and are associated with large issuance amounts (Johnson, 1997; Hooks, 2003). Therefore, it could be argued that the decrease in bond credit spreads may not be the result of purchasing D&O insurance but is caused by other features (omitted variables) of a firm, leading to self-selection bias. We implement the Heckman two-stage procedure to mitigate omitted variable bias.

Following Wang and Gao (2017), in the first-stage regression, we regress $BondDum_{i,t}$ with $Size_{i,t}$, $Lev_{i,t}$, $ROA_{i,t}$, $Growth_{i,t}$, $CF_{i,t}$, $Risk_{i,t}$ (three-year volatility of $ROA_{i,t}$), $AltZ_{i,t}$ (Z score developed by Altman, 1968),[9] $State_{i,t}$ (ownership structure), $Top1_{i,t}$ (shareholding ratio of the controlling shareholder), $Independent_{i,t}$ (board independence), $Big4_{i,t}$ (a dummy variable that equals 1 if a firm is audited by a Big Four auditor), $Equity_{i,t}$ (natural logarithm of net assets), $DistributionProfit_{i,t}$ (three-year average of undistributed profits over total assets), $ExBond_{i,t}$ (natural logarithm of bonds payable), $ShortTerm_{i,t}$ (percentage of short-term loans in total assets) and $LongTerm_{i,t}$ (proportion of long-term loans in total assets).

The inverse Mills' ratio (IMR) generated from the first-stage probit model is then included in the second stage to control for self-selection bias. The other specification of the second-stage model remains the same as in Model (1) in Section 4.2. Table 5 presents the results of the Heckman two-stage procedure. In the second-stage regression, the coefficient of $Doins_{i,t}$ is statistically negative and significant at the 1% level, and the coefficient of $IMR_{i,t}$ is statistically positive and significant at the 1% level, illustrating that D&O insurance coverage still negatively affects bond credit spreads after controlling for self-selection bias.[10]

[8] Due to the concern that the IV *OverseaBack* may affect credit spreads via other channels, we construct a new IV to address endogeneity issues. The first case of D&O insurance compensation was in 2011, during which AIG compensated GAC Changfeng in the sum of 0.8 million Chinese yuan after civil lawsuits concerning GAC Changfeng's financial misstatements. We use this external shock as the IV of D&O insurance ($Doins_{i,t}$). The case provides a more direct and better understanding of D&O insurance in risk mitigation, while credit spreads are not affected by this case, making it a reasonable IV. Given that the insurance claim occurred in 2011, we follow Hu et al. (2019) and construct an indicator variable (*IV-2011*) that equals 1 if the year is 2012 and after and 0 otherwise. We then adopt 2SLS, GMM and LIML procedures and find that the results are qualitatively and quantitatively similar.

[9] Following Altman (1968), we use our sample firms to estimate the coefficient of each variable and then calculate the Z score using the equation: $AltZ = 1.2 \times$ (Working Capital / Total Assets) $+ 1.4 \times$ (Retained Earnings / Total Assets) $+ 3.3 \times$ (EBIT / Total Assets) $+ 0.6 \times$ (Total Value of Common Stocks Outstanding / Total Liabilities) $+ 1 \times$ Total Asset Turnover.

[10] To further address endogeneity concerns caused by omitted variables, we follow Cinelli et al. (2020) and conduct a sensitivity analysis, in which we examine how strong an omitted variable should be to overturn our baseline results. Using $Size_{i,t}$ for comparison purposes, the baseline results remain statistically negative after adding an omitted variable that has three times the explanatory power of $Size_{i,t}$.

Table 5
Heckman two-stage analysis of the impact of D&O insurance on bond credit spreads.

First-stage regression: $BondDum_{i,t}$		Second-stage regression: $CS_{i,t}$	
$Size_{i,t}$	−0.5111***	$Doins_{i,t}$	−0.3034***
	(−4.77)		(−9.23)
$Lev_{i,t}$	3.0036***	$Size_{i,t}$	−0.0469**
	(8.92)		(−2.15)
$ROA_{i,t}$	0.1878	$Lev_{i,t}$	1.4394***
	(0.50)		(9.87)
$Growth_{i,t}$	−0.1022***	$ROA_{i,t}$	−4.6105***
	(−3.43)		(−8.69)
$CF_{i,t}$	−1.0307***	$Growth_{i,t}$	0.0967**
	(−4.53)		(2.00)
$Risk_{i,t}$	−0.5784**	$CF_{i,t}$	0.3542
	(−2.33)		(1.26)
$AltZ_{i,t}$	−0.1658***	$Tang_{i,t}$	−0.0255
	(−5.93)		(−0.31)
$State_{i,t}$	−0.1104***	$Board_{i,t}$	−0.3525***
	(−3.35)		(−5.05)
$Top1_{i,t}$	−0.0056***	$Independent_{i,t}$	−1.4051***
	(−5.41)		(−5.11)
$Independent_{i,t}$	−0.3237	$Dual_{i,t}$	0.3285***
	(−1.25)		(7.27)
$Big4_{i,t}$	−0.0859	$BondSize_{i,t}$	−0.0739***
	(−1.53)		(−3.09)
$Equity_{i,t}$	0.9237***	$BondTerm_{i,t}$	−0.0406**
	(8.43)		(−2.01)
$DistributionProfit_{i,t}$	1.1567***	$BondSecured_{i,t}$	0.2334***
	(5.47)		(7.26)
$ExBond_{i,t}$	0.1054***	$BondPut_{i,t}$	0.0824***
	(67.07)		(2.68)
$ShortTerm_{i,t}$	−1.1888***	$BondCredit_{i,t}$	−0.4624***
	(−6.85)		(−20.94)
$LongTerm_{i,t}$	−1.5689***	$IMR_{i,t}$	0.1646***
	(−7.37)		(5.44)
Constant	−11.3016***	*Constant*	6.7902***
	(−26.84)		(14.03)
Year fixed effects	Yes	Year fixed effects	Yes
Industry fixed effects	Yes	Industry fixed effects	Yes
Observations	22,962	Observations	6,963
Pseudo R^2	0.6826	Adjusted R^2	0.3813

Note: The t-statistics are reported in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

6.1.3. PSM and EB procedures

D&O coverage among Chinese firms is much lower than that in developed capital markets. An insurance company may intend to select potential clients with low default risk. Thus, insured firms may have better corporate governance and lower default risk than uninsured firms. In other words, the negative effects between $CS_{i,t}$ and $Doins_{i,t}$ may not be attributed to D&O insurance monitoring but be caused by the "screening effects" of insurance companies. This will cause endogeneity concerns as the difference exists not only in the decision to purchase D&O insurance but also in other features, observable or not. To alleviate this issue, we implement the PSM procedure and the EB procedure to match the treatment group and control group according to the factors that may cause confounding effects, after which we can use a matched sample to further test the robustness of our results.

For PSM, we first construct a logit model for the factors influencing the purchase of D&O insurance. According to Yuan et al. (2016), we use a series of variables including $Size_{i,t}$, $Lev_{i,t}$, $ROA_{i,t}$, $Lnage_{i,t}$ (firm age), $Independent_{i,t}$, $LnIC_{i,t}$ (quality of internal controls), $State_{i,t}$ and $CrossList_{i,t}$, as matching variables to cal-

culate the propensity scores for the sample firms. We then apply nearest neighbor matching without replacement to match three uninsured firms to each insured firm (1:3 matching), to address the "screening effects." After testing the covariate balance of the matched sample, we re-estimate Model (1) with the matched sample.

As proposed by Hainmueller (2012), the EB procedure has an advantage in processing multidimensional data and can accurately match a treatment group with control groups through multidimensional adjustments to first-order moments, second-order cross moments and third-order moments of all covariates.

Panel A of Appendix II reports the results of the logit model for the PSM procedure. Consistent with prior studies (Yuan et al., 2016; Lai and Tai, 2019), the coefficients of $Size_{i,t}$, $Lnage_{i,t}$, $State_{i,t}$ and $CrossList_{i,t}$ are all significantly positive, indicating that large firms, older firms, SOEs and cross-listed firms are more likely to purchase D&O insurance. The negative impact of $ROA_{i,t}$ is also consistent with the literature (Jia et al., 2019). Panel B shows a large decrease in bias between the treatment group and the control group. There are no significant differences in the means of all covariates, thus meeting the "balanced condition assumption." Panel C of Appendix II reports the results of the EB test, illustrating a decrease in the differences between all

Table 6
The impact of D&O insurance on bond credit spreads with a matched sample.

Variable	PSM	EB
	$CS_{i,t}$	$CS_{i,t}$
$Doins_{i,t}$	−0.1542***	−0.0676**
	(−3.13)	(−2.00)
$Size_{i,t}$	−0.0248	−0.0294
	(−0.78)	(−1.23)
$Lev_{i,t}$	0.8257***	0.9080***
	(2.84)	(4.47)
$ROA_{i,t}$	−3.5147***	−4.0277***
	(−2.96)	(−4.47)
$Growth_{i,t}$	0.1150	0.0965
	(1.05)	(1.15)
$CF_{i,t}$	0.5209	1.1041**
	(0.92)	(2.49)
$Tang_{i,t}$	−0.2085	−0.1503
	(−1.47)	(−1.40)
$Board_{i,t}$	−0.4350***	−0.3798***
	(−3.59)	(−4.29)
$Independent_{i,t}$	−1.9707***	−2.0227***
	(−4.69)	(−7.00)
$Dual_{i,t}$	−0.1775**	−0.1928***
	(−2.10)	(−3.73)
$BondSize_{i,t}$	−0.0634	−0.0407
	(−1.59)	(−1.41)
$BondTerm_{i,t}$	−0.0339	0.0033
	(−0.95)	(0.13)
$BondSecured_{i,t}$	0.2548***	0.2575***
	(4.56)	(6.37)
$BondPut_{i,t}$	0.0188	−0.0234
	(0.35)	(−0.61)
$BondCredit_{i,t}$	−0.4320***	−0.4572***
	(−10.36)	(−14.76)
Constant	7.2218***	7.1929***
	(8.36)	(14.25)
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Observations	1,973	7,626
Adjusted R^2	0.3137	0.3084

Note: The t-statistics are reported in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

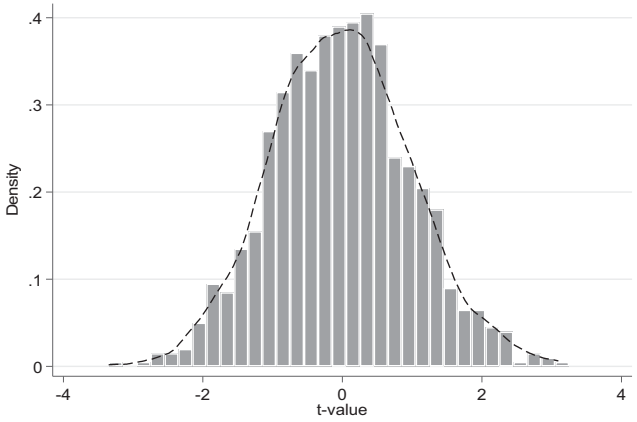

Fig. 2. Placebo test of the impact of D&O insurance on bond credit spreads.

variables between the treatment group and the control group. We then re-estimate Model (1) and report the results in Table 6. The coefficients of $Doins_{i,t}$ are statistically negative and significant at the 1% and 5% levels following the PSM and EB procedures, respectively.

6.2. Placebo test

Considering that the statistical significance of our baseline results may be driven by some random factors, we follow Li et al. (2016) and conduct a placebo test to eliminate this concern. We estimate Model (1) with the purchase of D&O insurance randomly assigned to the sample firms. The baseline results will not hold if we still identify a negative relationship between D&O insurance and credit spreads. We repeat the placebo test 1,000 times and draw the virtual distribution of the t-value of $Doins_{i,t}$ in Fig. 2. The symmetric curve around the origin demonstrates the non-existence of a virtual correlation between D&O insurance and bond credit spreads, thus validating our main results.

6.3. Other robustness tests

Table 7 provides the results of additional robustness tests, including the following:

1) Use of alternative explanatory variables. We use $Doins2_{i,t}$ (the history of D&O coverage) and $Doins3_{i,t}$ (a dummy variable that equals 1 if firms disclose D&O insurance contract details) as alternative explanatory variables to estimate Model (1) and report a negative relationship significant at the 1% level in columns (1) and (2) of Table 7.
2) Use of alternative explained variables. We replace $CS_{i,t}$ with $CS2_{i,t}$ (the difference between bond YTM and the 5-year fixed deposit rate), $CS3_{i,t}$ (the difference between bond YTM and the 1-year fixed deposit rate) and $CS4_{i,t}$ (the credit spread of the bond with the largest issuance amount if a firm issues more than one bond) as a robustness test. The coefficients in columns (3) to (5) of Table 7 remain significantly negative at the 1% level.
3) Given the impact of the global financial crisis (GFC), we exclude observations for 2008 and 2009 to re-estimate Model (1) and reach a similar conclusion to that shown in column (6).
4) Fixed effects model. We use a fixed effects model to control for time-invariant firm characteristics. The results in column (7) of Table 7 show that D&O insurance is still negatively associated with bond credit spreads.
5) The interaction of industry and year fixed effects. It is possible that industry effects and time effects may interact, i.e., industry effects only occur in specific years. We add the interaction term of industry and year fixed effects to re-estimate Model (1) and obtain similar results to those shown in column (8) of Table 7.

Table 7
Other robustness tests of the impact of D&O insurance on bond credit spreads.

Variable	Panel A: Alternative D&O insurance measure		Panel B: Alternative bond credit spread measure			Panel C: Excluding the GFC	Panel D: Fixed effects model	Panel E: Controlling Year × Industry
	$CS_{i,t}$	$CS_{i,t}$	$CS2_{i,t}$	$CS3_{i,t}$	$CS4_{i,t}$	$CS_{i,t}$	$CS_{i,t}$	$CS_{i,t}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Doins2_{i,t}$	−0.0342***							
	(−9.47)							
$Doins3_{i,t}$		−0.1987***						
		(−4.49)						
$Doins_{i,t}$			−0.4411***	−0.4384***	−0.1868***	−0.3026***	−0.2421***	−0.2936***
			(−7.41)	(−7.43)	(−3.74)	(−9.11)	(−5.27)	(−8.86)
$Size_{i,t}$	−0.0772***	−0.0841***	−0.0643**	−0.0664**	−0.0840***	−0.0699***	−0.1023***	−0.0772***
	(−4.48)	(−4.81)	(−1.97)	(−2.04)	(−3.02)	(−3.95)	(−4.02)	(−4.38)
$Lev_{i,t}$	1.3558***	1.2336***	1.9455***	1.9357***	0.9394***	1.2962***	1.6330***	1.2974***
	(9.91)	(9.05)	(6.83)	(6.85)	(5.54)	(9.30)	(9.38)	(9.31)
$ROA_{i,t}$	−5.9646***	−6.0255***	−8.7483***	−8.7977***	−7.1967***	−6.2636***	−3.5239***	−5.8999***
	(−10.84)	(−10.89)	(−7.07)	(−7.14)	(−10.70)	(−11.12)	(−6.49)	(−10.30)
$Growth_{i,t}$	0.0954*	0.1097**	−0.0294	−0.0253	0.1737***	0.1010*	0.0667	0.1184**
	(1.81)	(2.09)	(−0.28)	(−0.24)	(2.63)	(1.90)	(1.64)	(2.13)
$CF_{i,t}$	0.2169	0.2032	0.9160*	0.8896*	0.1863	0.2127	0.4149*	0.0970
	(0.79)	(0.73)	(1.81)	(1.78)	(0.56)	(0.76)	(1.74)	(0.34)
$Tang_{i,t}$	−0.1671**	−0.1360*	−0.5270***	−0.5199***	−0.0491	−0.1721**	−0.0287	−0.1601**
	(−2.10)	(−1.71)	(−3.52)	(−3.49)	(−0.48)	(−2.13)	(−0.27)	(−2.00)
$Board_{i,t}$	−0.2486***	−0.2253***	−0.3733***	−0.3779***	−0.1737*	−0.2426***	−0.2714***	−0.2209***
	(−3.58)	(−3.25)	(−2.87)	(−2.91)	(−1.91)	(−3.46)	(−3.05)	(−3.16)
$Independent_{i,t}$	−1.3805***	−1.5247***	−1.8903***	−1.8876***	−0.8957**	−1.4955***	−1.4888***	−1.2716***
	(−5.36)	(−5.90)	(−3.81)	(−3.84)	(−2.56)	(−5.77)	(−5.18)	(−4.90)
$Dual_{i,t}$	−0.2840***	−0.3047***	−0.3137***	−0.3152***	−0.2149***	−0.2839***	−0.1644***	−0.2990***
	(−7.22)	(−7.72)	(−4.12)	(−4.16)	(−4.27)	(−7.20)	(−3.91)	(−7.51)
$BondSize_{i,t}$	−0.0882***	−0.0905***	−0.0241	−0.0242	−0.0846**	−0.0899***	−0.0950***	−0.0756***
	(−3.82)	(−3.91)	(−0.54)	(−0.55)	(−2.32)	(−3.83)	(−2.58)	(−3.25)
$BondTerm_{i,t}$	−0.0395**	−0.0457**	−0.0516	−0.0515	−0.0255	−0.0406**	−0.0008	−0.0374**
	(−2.11)	(−2.42)	(−1.15)	(−1.14)	(−1.03)	(−2.15)	(−0.04)	(−1.97)
$BondSecured_{i,t}$	0.2250***	0.2282***	0.3171***	0.3212***	0.2671***	0.2282***	0.2404***	0.2072***
	(7.26)	(7.38)	(5.24)	(5.34)	(6.40)	(7.23)	(4.56)	(6.51)
$BondPut_{i,t}$	0.1126***	0.1190***	0.1532***	0.1537***	−0.0286	0.1110***	0.2067***	0.1112***
	(3.84)	(4.04)	(2.70)	(2.72)	(−0.75)	(3.75)	(4.41)	(3.77)
$BondCredit_{i,t}$	−0.4424***	−0.4483***	−0.5613***	−0.5599***	−0.5043***	−0.4375***	−0.4815***	−0.4469***
	(−21.67)	(−21.88)	(−14.27)	(−14.34)	(−18.22)	(−21.26)	(−15.89)	(−21.44)
Constant	7.8234***	8.0974***	5.8025***	7.3630***	8.0432***	6.1455***	8.2324***	8.0701***
	(19.61)	(20.19)	(7.83)	(10.12)	(13.38)	(15.87)	(15.77)	(15.89)

(*continued on next page*)

Table 2 (*continued*)

Variable	Panel A: Alternative D&O insurance measure		Panel B: Alternative bond credit spread measure			Panel C: Excluding the GFC	Panel D: Fixed effects model	Panel E: Controlling Year × Industry
	$CS_{i,t}$	$CS_{i,t}$	$CS2_{i,t}$	$CS3_{i,t}$	$CS4_{i,t}$	$CS_{i,t}$	$CS_{i,t}$	$CS_{i,t}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	No	Yes
Firm fixed effects	No	No	No	No	No	No	Yes	No
Year × Industry fixed effects	No	No	No	No	No	No	No	Yes
Observations	7,783	7,783	7,783	7,783	4,480	7,618	7,783	7,783
Adjusted R^2	0.3691	0.3643	0.2185	0.2220	0.3684	0.3678	0.3467	0.3776

Note: The t-statistics are reported in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 8
Channel analysis regression results.

Variable	Panel A: Internal governance		Panel B: External supervision		Panel C: Information asymmetry		Panel D: Default risk	
	$LnIC_{i,t}$	$Score_{i,t}$	$Big4_{i,t}$	$Intown_{i,t}$	$Atran_{i,t}$	$Restate_{i,t}$	$EDP_{i,t}$	$AltZ_{i,t}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$Doins_{i,t}$	−3.8717***	−0.4737***	−0.4444***	−0.7237***	−0.4848***	−0.2515***	−0.2434***	−0.4865***
	(−2.99)	(−11.15)	(−8.69)	(−5.79)	(−8.93)	(−7.31)	(−7.26)	(−7.22)
$Doins_{i,t} \times \Delta$	0.5490***	0.3908***	0.3703***	0.0063***	0.0209***	−0.2588***	−0.6564***	0.1391***
	(2.79)	(7.88)	(5.55)	(3.94)	(4.60)	(−3.14)	(−4.23)	(3.37)
Δ	−0.7064***	−0.3546***	−0.2160***	−0.0077***	−0.0046*	0.2406***	0.2973***	−0.0725**
	(−5.17)	(−11.80)	(−5.05)	(−8.51)	(−1.71)	(6.06)	(3.07)	(−2.31)
$Size_{i,t}$	−0.0453**	−0.0617***	−0.0668***	−0.0321*	−0.0780***	−0.0718***	−0.0762***	−0.0730***
	(−2.51)	(−3.53)	(−3.79)	(−1.81)	(−4.49)	(−4.15)	(−4.41)	(−4.20)
$Lev_{i,t}$	1.1569***	1.3386***	1.2972***	1.2714***	1.3180***	1.2729***	1.2227***	1.1396***
	(8.55)	(9.77)	(9.52)	(9.38)	(9.64)	(9.36)	(8.78)	(6.83)
$ROA_{i,t}$	−4.8011***	−6.0041***	−5.9557***	−5.6891***	−6.0692***	−5.9511***	−5.9616***	−5.6171***
	(−8.08)	(−10.85)	(−10.78)	(−10.25)	(−10.98)	(−10.77)	(−10.82)	(−9.50)
$Growth_{i,t}$	0.1428***	0.0762	0.0991*	0.1059**	0.1034**	0.0908*	0.1148**	0.1046**
	(2.68)	(1.46)	(1.89)	(2.03)	(1.96)	(1.72)	(2.19)	(1.99)
$CF_{i,t}$	0.3044	0.3842	0.3124	0.3629	0.1722	0.2727	0.1818	0.2235
	(1.08)	(1.41)	(1.13)	(1.32)	(0.62)	(0.99)	(0.66)	(0.81)
$Tang_{i,t}$	−0.1332*	−0.1051	−0.2049**	−0.1810**	−0.1462*	−0.1787**	−0.1685**	−0.1633**
	(−1.69)	(−1.32)	(−2.56)	(−2.29)	(−1.81)	(−2.25)	(−2.12)	(−2.06)
$Board_{i,t}$	−0.2383***	−0.2459***	−0.2296***	−0.2146***	−0.2336***	−0.2449***	−0.2298***	−0.2476***
	(−3.47)	(−3.56)	(−3.33)	(−3.11)	(−3.38)	(−3.53)	(−3.33)	(−3.58)
$Independent_{i,t}$	−1.3810***	−0.2211	−1.3904***	−1.3620***	−1.4404***	−1.4539***	−1.4172***	−1.4313***
	(−5.46)	(−0.80)	(−5.41)	(−5.29)	(−5.61)	(−5.66)	(−5.52)	(−5.58)
$Dual_{i,t}$	−0.2969***	−0.1503***	−0.2771***	−0.2487***	−0.2726***	−0.2765***	−0.2727***	−0.2797***
	(−7.54)	(−3.62)	(−7.08)	(−6.29)	(−6.93)	(−7.09)	(−6.94)	(−7.12)
$BondSize_{i,t}$	−0.0898***	−0.0818***	−0.0868***	−0.0726***	−0.0865***	−0.0858***	−0.0826***	−0.0858***
	(−3.89)	(−3.57)	(−3.77)	(−3.14)	(−3.73)	(−3.72)	(−3.57)	(−3.71)
$BondTerm_{i,t}$	−0.0299	−0.0426**	−0.0437**	−0.0416**	−0.0421**	−0.0395**	−0.0383**	−0.0409**
	(−1.61)	(−2.28)	(−2.33)	(−2.24)	(−2.24)	(−2.11)	(−2.05)	(−2.18)
$BondSecured_{i,t}$	0.2099***	0.2332***	0.2094***	0.2402***	0.2151***	0.2155***	0.2202***	0.2204***
	(6.82)	(7.53)	(6.73)	(7.74)	(6.93)	(6.97)	(7.09)	(7.10)
$BondPut_{i,t}$	0.1021***	0.0905***	0.1149***	0.1232***	0.1146***	0.1088***	0.1096***	0.1195***
	(3.48)	(3.13)	(3.93)	(4.23)	(3.90)	(3.72)	(3.74)	(4.08)
$BondCredit_{i,t}$	−0.4402***	−0.4131***	−0.4267***	−0.4288***	−0.4347***	−0.4331***	−0.4388***	−0.4399***
	(−21.44)	(−20.39)	(−20.64)	(−21.15)	(−21.28)	(−21.25)	(−21.54)	(−21.58)
Constant	11.7673***	6.7861***	7.5954***	6.9955***	7.8606***	7.7090***	7.8291***	7.9989***
	(13.49)	(16.50)	(18.80)	(17.19)	(19.62)	(19.29)	(19.64)	(19.37)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7,783	7,783	7,783	7,783	7,783	7,783	7,783	7,783
Adjusted R^2	0.3687	0.3799	0.3712	0.3755	0.3698	0.3722	0.3708	0.3695

Note: The t-statistics are reported in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

7. Channel analysis

In this section, we explore four channels through which D&O insurance reduces bond credit spreads. It is organized as follows. First, to test the internal governance mechanism, we follow prior studies (Bai et al., 2004; Yuan et al., 2016) and use $LnIC_{i,t}$ and $Score_{i,t}$ (a comprehensive index of corporate governance) as two proxies.[11] Second, to investigate the external monitoring mechanism, we proxy external monitoring with

[11] We first conduct principle component analysis (PCA) by using a series of variables including $Top1_{i,t}$, the shareholding ratio of the second- to the tenth-largest shareholders ($Top2\_10_{i,t}$), $Dual_{i,t}$, $Independent_{i,t}$, executive shareholding ratio ($Exeshare_{i,t}$), $State_{i,t}$, $CrossList_{i,t}$ and the existence of a parent company ($Parent_{i,t}$). We then use the selected PCA factors to calculate $Score_{i,t}$.

Table 9
Regression results with the four economic channels.

$Doins_{i,t}$	Internal governance: $LnIC_{i,t}$		External supervision: $Big4_{i,t}$		Information asymmetry: $Atran_{i,t}$		Default risk: $EDP_{i,t}$		Controls	Year fixed effects	Industry fixed effects	Observations	Adjusted R^2
	$Doins_{i,t} \times \Delta$	Δ	$Doins_{i,t} \times \Delta$	Δ	$Doins_{i,t} \times \Delta$	Δ	$Doins_{i,t} \times \Delta$	Δ					
−3.5610***	0.4646**	−0.6645***	0.3073***	−0.2202***	0.0202***	−0.0068**	−0.5626***	0.2660***	Yes	Yes	Yes	7,783	0.3738
(−2.64)	(2.27)	(−4.81)	(4.64)	(−5.17)	(4.52)	(−2.53)	(−3.64)	(2.72)					

Note: The t-statistics are reported in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Table 10
The impact of D&O insurance on bond credit spreads: Cross-sectional analysis.

Variable	(1)	(2)	(3)
$Doins_{i,t}$	−0.4953***	−0.4327***	−0.3741***
	(−6.00)	(−3.76)	(−9.01)
$Doins_{i,t} \times State_{i,t}$	0.3404***		
	(3.95)		
$State_{i,t}$	−0.8218***		
	(−24.17)		
$Doins_{i,t} \times Marketization_{i,t}$		0.2039*	
		(1.72)	
$Marketization_{i,t}$		−0.2494***	
		(−6.89)	
$Doins_{i,t} \times Reputation_{i,t}$			0.1978***
			(3.39)
$Reputation_{i,t}$			0.0148
			(0.43)
$Size_{i,t}$	−0.0980***	−0.0716***	−0.0725***
	(−5.79)	(−4.12)	(−4.16)
$Lev_{i,t}$	1.3630***	1.1724***	1.2902***
	(10.15)	(8.53)	(9.47)
$ROA_{i,t}$	−6.5279***	−6.0705***	−6.0262***
	(−11.86)	(−11.06)	(−10.89)
$Growth_{i,t}$	0.0696	0.1031**	0.0999*
	(1.36)	(1.97)	(1.90)
$CF_{i,t}$	0.1844	0.2238	0.2139
	(0.71)	(0.82)	(0.77)
$Tang_{i,t}$	0.1419*	−0.2167***	−0.1524*
	(1.80)	(−2.72)	(−1.91)
$Board_{i,t}$	−0.0428	−0.2540***	−0.2307***
	(−0.63)	(−3.67)	(−3.33)
$Independent_{i,t}$	−0.6744***	−1.3914***	−1.3787***
	(−2.72)	(−5.43)	(−5.35)
$Dual_{i,t}$	−0.1412***	−0.2985***	−0.2852***
	(−3.75)	(−7.62)	(−7.25)
$BondSize_{i,t}$	−0.0595***	−0.0802***	−0.0882***
	(−2.68)	(−3.50)	(−3.81)
$BondTerm_{i,t}$	−0.0349*	−0.0426**	−0.0387**
	(−1.89)	(−2.27)	(−2.07)
$BondSecured_{i,t}$	0.2364***	0.2291***	0.2345***
	(7.88)	(7.41)	(7.47)
$BondPut_{i,t}$	0.0172	0.1108***	0.1309***
	(0.62)	(3.81)	(4.24)
$BondCredit_{i,t}$	−0.3644***	−0.4389***	−0.4412***
	(−18.33)	(−21.56)	(−21.68)
$Constant_{i,t}$	7.4132***	8.0233***	7.6949***
	(18.62)	(20.09)	(19.17)
Year fixed effects	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Observations	7,783	7,783	7,783
Adjusted R^2	0.4185	0.3732	0.3696

Note: The t-statistics are reported in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

$Big4_{i,t}$ and $Intown_{i,t}$ (shareholding of institutional investors). Third, for information asymmetry, following Bhattacharya et al. (2003) and Park and Wu (2009), we use $Atran_{i,t}$ (information transparency measured by the average of the deciles assigned to earnings aggressiveness and earnings smoothing) and $Restate_{i,t}$ (a dummy variable that equals 1 if financial restatements occur) as proxies. Last, for the default risk channel, we follow Gao et al. (2020) and construct two proxies, $EDP_{i,t}$ (naive default probability by Bharath and Shumway, 2008) and $AltZ_{i,t}$. Detailed definitions of the variables are shown in Appendix I.

We investigate how D&O insurance reduces bond credit spreads by regressing Model (2), in which the interaction term of the explanatory variable and the channel variable is added. Δ proxies various channels, including internal governance ($LnIC_{i,t}$ and $Score_{i,t}$), external monitoring ($Big4_{i,t}$ and $Intown_{i,t}$), information asymmetry ($Atran_{i,t}$ and $Restate_{i,t}$) and default risk ($EDP_{i,t}$ and $AltZ_{i,t}$). The specification of the other variables is the same as in Model (1).

$$CS_{i,t} = \alpha_0 + \alpha_1 Doins_{i,t} + \alpha_2 Doins_{i,t} \times \Delta + \alpha_3 \Delta + \sum_{q=4}^{m} \alpha_q (ControlVariable_{i,t}) + \delta_j + \tau_t + \varepsilon_{i,t} \quad (2)$$

Table 8 presents the results for all channels. As shown in Panels A to D, the negative correlation is more significant when there is weak internal governance, insufficient external monitoring, more asymmetric information and higher default risk.

We then simultaneously consider the impacts of the four channels and re-run the regression of Model (2). It should be noted that we only add one proxy for each channel to mitigate multicollinearity. As shown in Table 9, the coefficients of all of the interaction terms are significant at the 1% level, illustrating that D&O insurance can affect bond credit spreads through the four channels. Furthermore, after controlling for the characteristics of the channels and bonds, the coefficient of $Doins_{i,t}$ remains negative and significant at the 1% level, indicating the direct effect of D&O insurance on reducing bond credit spreads.

8. Further analysis

8.1. Cross-sectional analysis

Our results show that D&O insurance can reduce credit spreads via multiple channels. In Section 8.1, we conduct cross-sectional analysis to examine how heterogeneous factors, including the nature of ownership, the level of marketization and the reputation of the rating agency, affect the negative relationship between D&O insurance and bond credit spreads. Heterogeneous factors cannot easily be changed or be out of a firm's control, yet they cause heterogeneity in some aspects of default risk, governance environments and level of information asymmetry.

8.1.1. The nature of ownership

The nature of ownership should be taken into consideration when exploring China's economic problems in the era of economic transition. Specifically, the nature of ownership leads to different perceptions of issuers' default risk. When SOEs face a repayment crisis, the local government could use tax relief, capital raising or coordination with banks to prevent a material default. Bond investors have "rigid repayment" expectations and perceive low risk for bonds issued by SOEs, which weakens the negative effect of D&O insurance on credit spreads (Tong et al., 2021). Given the lack of implicit guarantees for non-SOEs, their default risk is more closely associated with their operational performance and governance mechanism, meaning that D&O insurance should be more influential in reducing credit spreads. Therefore, we use $State_{i,t}$ as a proxy. The results of column (1) in Table 10 show that the coefficient of $Doins_{i,t} \times State_{i,t}$ remains positive and significant at the 1% level, illustrating that the impact of D&O insurance on decreasing credit spreads is more pronounced in non-SOEs than in SOEs.

8.1.2. Level of marketization

The differences in geographical location, resource endowment and national policy between Chinese provinces result in an obvious imbalance in the progress of marketization, reflected in the heterogenous governance environments faced by issuers. A high level of marketization provides more rounded government supervision and market restrictions, forcing firms to develop better internal governance to constrain managerial opportunism. This in turn reduces the ex-ante cost of information searching and investors' ex-post costs of supervision, leading to lower risk premiums. D&O insurance may play a limited role in reducing bond credit spreads if the issuers are located in areas with a high level of marketization. Following the literature (Wang

Table 11
Alternative explanation: The eyeball effect.

Variable	(1)
$Doins_{i,t}$	−0.3174***
	(−6.63)
$Doins_{i,t} \times Public_{i,t}$	0.0399
	(0.68)
$Public_{i,t}$	0.0440
	(1.31)
$Size_{i,t}$	−0.0838***
	(−4.53)
$Lev_{i,t}$	1.3000***
	(9.54)
$ROA_{i,t}$	−6.0991***
	(−11.03)
$Growth_{i,t}$	0.1024*
	(1.94)
$CF_{i,t}$	0.2304
	(0.84)
$Tang_{i,t}$	−0.1675**
	(−2.10)
$Board_{i,t}$	−0.2354***
	(−3.40)
$Independent_{i,t}$	−1.4455***
	(−5.63)
$Dual_{i,t}$	−0.2817***
	(−7.16)
$BondSize_{i,t}$	−0.0836***
	(−3.61)
$BondTerm_{i,t}$	−0.0414**
	(−2.21)
$BondSecured_{i,t}$	0.2258***
	(7.26)
$BondPut_{i,t}$	0.1135***
	(3.87)
$BondCredit_{i,t}$	−0.4405***
	(−21.54)
Constant	8.0166***
	(18.95)
Year fixed effects	Yes
Industry fixed effects	Yes
Observations	7,783
Adjusted R^2	0.3689

Note: The t-statistics are reported in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

et al., 2008; Yuan et al., 2016), we use the marketization index developed by Fan et al. (2016) to measure the level of regional marketization ($Marketization_{i,t}$). As shown in column (2) of Table 10, the coefficient of $Doins_{i,t} \times Marketization_{i,t}$ remains positive and significant at the 10% level, indicating that the impact of D&O insurance on decreasing credit spreads is more pronounced in regions with a low level of marketization. This also supports the claim that D&O insurance affects credit spreads through governance channels.

8.1.3. The reputation of rating agencies

Rating agencies play an important role in the bond market by providing information about bond issuers' credit risk. Rating agencies that provide effective and accurate ratings can develop a long-term reputation, thereby enhancing investor confidence and alleviating information asymmetry. This may weaken the effect of D&O insurance on credit spreads via the information asymmetry channel. Therefore, we use $Reputation_{i,}$

$_t$ (a dummy variable that equals 1 if the issuers employ China Credit International or United Credit for credit rating and 0 otherwise) as a proxy and examine whether variation in the reputation of rating agencies leads to differences in the impact of D&O insurance on credit spreads. The results of column (3) in Table 10 show that the coefficient of $Doins_{i,t} \times Reputation_{i,t}$ remains positive and significant at the 1% level, illustrating that D&O insurance is associated with tighter bond credit spreads if a firm employs a rating agency with a poorer reputation, supporting the claim that D&O insurance can affect bond credit spreads via the information asymmetry channel.

8.2. An alternative explanation: The eyeball effect

The limited coverage of D&O insurance among Chinese listed firms may cause an eyeball effect whereby firms that purchase D&O insurance may become capital market superstars and receive more external attention. This prevents insured firms from hiding negative news and improves their information transparency, which in turn reduces the cost of bond financing. Considering the possibility of an alternative explanation, we investigate whether the effect of D&O insurance on bond credit spreads varies with external attention. The proxy is public attention ($Public_{i,t}$), measured as the average value of the annual web search index for each listed firm.[12] The results in Table 11 are similar to our main results, showing that D&O insurance tightens bond credit spreads at the 1% significance level. However, the coefficient of $Doins_{i,t} \times Public_{i,t}$ is not significant, illustrating that external attention does not affect the role of D&O insurance in reducing credit spreads, and therefore we reject the eyeball effect as an alternative explanation.

9. Conclusion

Using a unique dataset that combines the purchase of D&O insurance by Chinese listed firms with bond credit spreads, we empirically examine whether D&O insurance affects bond credit spreads. We find that D&O insurance is associated with tighter credit spreads. This association is robust to a series of robustness tests, including the IV approach, the Heckman two-stage model, PSM, a placebo test and alternative explanatory (explained) variables and alternative fixed effects models. The results of our channel analysis imply that D&O insurance reduces credit spreads via the channels of internal governance, external monitoring, information asymmetry and default risk. Further analysis illustrates that the effect of D&O insurance on credit spreads is more pronounced if a firm is a non-SOE, is located in a low-marketization area or if it employs rating agencies with a bad reputation. We also confirm that this negative relationship is not driven by the eyeball effect.

Contrary to the conclusion that D&O insurance negatively affects corporate governance in developed capital markets, we identify some positive governance effects of D&O insurance on reducing bond credit spreads through improved internal governance and stronger external monitoring, given China's institutional environment. This finding further enriches the literature on the determinants of bond credit spreads as well as the economic consequences of D&O insurance.

Our findings also have policy implications. First, listed firms can purchase D&O insurance at their discretion, so they can improve their internal governance, mitigate agency issues, protect bond investors and ultimately reduce their credit spreads. Second, the D&O insurance products available to the Chinese market typically feature terms that are a direct translation of foreign terms and lack clearly defined boundaries of responsibility. To restrain managerial opportunism, insurance companies need to design more appropriate contractual terms that take into account the institutional and cultural background in China. Third, bond investors should incorporate D&O insurance coverage into the framework governing their investment decisions and systematically evaluate bond risk from the perspective of corporate governance, external monitoring and the quality of information disclosure to avoid a loss on their investment. Last, given the positive governance impact of D&O insurance, the China Securities Regulatory Committee may consider mandating disclosure of D&O insurance purchases by listed firms.

[12] This Baidu index is based on the massive search volume of Internet users on Baidu. It first defines the keywords and counts the frequency of searching via Baidu for each keyword. Then, the average weighted search frequency can be calculated. Detailed information can be found at: https://index.baidu.com/v2/index.html#/.

Declaration of competing interests

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix A. Variable definitions.

Variable name	Variable definition
Explained variable	
$CS_{i,t}$	The difference in yield to maturity (YTM) between a corporate bond and the Treasury bond with the closest maturity.
Explanatory variable	
$Doins_{i,t}$	A dummy variable that equals 1 if a firm purchases D&O insurance in a given year and 0 otherwise.
Control variables	
$Size_{i,t}$	Firm size, measured as the natural logarithm of total assets.
$Lev_{i,t}$	Firm's financial leverage ratio, calculated as total debt divided by total assets.
$ROA_{i,t}$	Firm's return on assets, calculated as net income divided by total assets.
$Growth_{i,t}$	Sales revenue in year t minus sales revenue in year t–1 divided by sales revenue in year t–1.
$CF_{i,t}$	Measured as cash flow divided by total assets.
$Tang_{i,t}$	Measured as tangible assets divided by total assets.
$Board_{i,t}$	Measured as the natural logarithm of the total number of board directors.
$Independent_{i,t}$	Number of independent directors divided by the total number of board directors.
$Dual_{i,t}$	An indicator variable that equals 1 if the CEO is not the Chairman of the firm and 0 otherwise.
$BondSize_{i,t}$	Measured as the natural logarithm of the bond issuance amount.
$BondTerm_{i,t}$	Measured as the natural logarithm of a bond's maturity.
$BondSecured_{i,t}$	An indicator variable that equals 1 if a bond is secured with collateral and 0 otherwise.
$BondPut_{i,t}$	An indicator variable that equals 1 if a new bond issue has a put option and 0 otherwise.
$BondCredit_{i,t}$	Defined as an ordered variable, with 5 for AAA ratings; 4 for AA+; 3 for AA; 2 for AA-; and 1 for A +.
Other variables	
$State_{i,t}$	An indicator variable that equals 1 if the firm is an SOE, and 0 otherwise.
$Exeshare_{i,t}$	The proportion of shares held by top executives.
$Top1_{i,t}$	The percentage of shares owned by the largest shareholder.
$CrossList_{i,t}$	An indicator variable that equals 1 if the firm is cross-listed, and 0 otherwise.
$Violation_{i,t}$	An indicator variable that equals 1 if the firm has a violation record, and 0 otherwise.
$Lnage_{i,t}$	The natural logarithm of the sum of the number of years that have elapsed since the firm was established plus 1.
$LnIC_{i,t}$	The natural logarithm of 1 plus the Chinese internal control quality index.
$Top2\_10_{i,t}$	The percentage of shares owned by the second to tenth largest shareholders.
$Parent_{i,t}$	An indicator variable that equals 1 if the firm has a parent company and 0 otherwise.

$Big4_{i,t}$	An indicator variable that equals 1 if the firm's auditor is one of the Big Four and 0 otherwise.
$Intown_{i,t}$	The percentage of shares owned by institutional investors.
$Atran_{i,t}$	The mean value of the decile assignment method of earnings stimulus and earnings smoothness.
$Restate_{i,t}$	An indicator variable that equals 1 if the firm announces a financial restatement and 0 otherwise.
$EDP_{i,t}$	According to Bharath and Shumway (2008).
$AltZ_{i,t}$	1.2×(Working Capital/Total Assets) + 1.4×(Retained Earnings/Total Assets) + 3.3×(Earnings Before Interest and Taxes/Total Assets) + 0.6×(Market Value of Equity/Book Value of Long-Term Debt) + (Net Sales/Total Assets).
$Marketization_{i,t}$	Measured as the regional marketization index (Fan et al., 2016).
$Reputation_{i,t}$	An indicator variable that equals 1 if the issuing firm hires a brand name rating agency (i.e., China Chengxin International Credit Rating Co., Ltd.,China Lianhe Credit Rating Co. Ltd.) and 0 otherwise.
$Public_{i,t}$	The natural logarithm of the sum of the number of web searches plus 1.

Appendix B. Additional tables of PSM and EB matching procedures.

Panel A: First-stage regression of PSM

Variable	$Doins_{i,t}$
$Size_{i,t}$	0.3130***
	(10.65)
$Lev_{i,t}$	−0.0601
	(−0.20)
$ROA_{i,t}$	−2.7005*
	(−1.80)
$Lnage_{i,t}$	1.0524***
	(10.28)
$Independent_{i,t}$	−0.2433
	(−0.47)
$LnIC_{i,t}$	0.0446
	(0.20)
$State_{i,t}$	1.1452***
	(11.21)
$CrossList_{i,t}$	2.1014***
	(26.40)
Constant	−13.8752***
	(−9.07)
Year fixed effects	Yes
Industry fixed effects	Yes
Observations	7,626
Pseudo R^2	0.2783

Note: The t-statistics are reported in brackets. ***, ** and * indicate significance at the 1%, 5% and 10% levels, respectively.

Panel B: Matching efficiency of PSM

Variable	Unmatched	Mean		%reduct		*t*-test	
	Matched	Treatment	Control	%bias	|bias|	t-value	p > |t|
$Size_{i,t}$	U	25.4890	24.1080	94.9000		33.3400	0.0000
	M	25.2890	25.2320	4.0000	95.8000	1.0800	0.2800
$Lev_{i,t}$	U	0.6327	0.6019	21.1000		7.0300	0.0000
	M	0.6352	0.6341	0.8000	96.3000	0.2200	0.8240
$ROA_{i,t}$	U	0.0279	0.0302	−7.7000		−2.5200	0.0120
	M	0.0280	0.0271	3.2000	58.2000	0.8200	0.4100
$Lnage_{i,t}$	U	2.9143	2.8690	12.5000		4.3600	0.0000
	M	2.8937	2.8764	4.8000	61.7000	1.2900	0.1960
$Independent_{i,t}$	U	0.3894	0.3784	16.9000		6.0100	0.0000
	M	0.3886	0.3856	4.5000	73.4000	1.2100	0.2270
$LnIC_{i,t}$	U	6.5633	6.5165	26.5000		9.8300	0.0000
	M	6.5583	6.5583	0.0000	99.9000	−0.0100	0.9930
$State_{i,t}$	U	0.9117	0.6147	74.5000		22.9000	0.0000
	M	0.9053	0.9040	0.3000	99.6000	0.1100	0.9110
$CrossList_{i,t}$	U	0.6285	0.1084	128.0000		51.6100	0.0000
	M	0.6014	0.6171	−3.9000	97.0000	−0.8600	0.3900

Panel C: Matching efficiency of EB matching

Variable	Treatment			Control before matching			Control after matching		
	Mean	Variance	Skewness	Mean	Variance	Skewness	Mean	Variance	Skewness
$Size_{i,t}$	25.4885	2.1468	0.0091	24.0998	2.0728	0.5985	25.4885	2.6160	0.2216
$Lev_{i,t}$	0.6327	0.0174	−0.4119	0.6042	0.0251	−0.2861	0.6327	0.0200	−0.3675
$ROA_{i,t}$	0.0279	0.0007	0.0235	0.0292	0.0012	−0.3336	0.0279	0.0009	−0.4422
$Lnage_{i,t}$	2.9143	0.1327	−0.5984	2.8696	0.1337	−1.0838	2.9143	0.1207	−0.9114
$Independent_{i,t}$	0.3894	0.0046	1.3818	0.3783	0.0040	1.7882	0.3894	0.0049	1.5862
$LnIC_{i,t}$	6.5633	0.0372	−5.7932	6.5164	0.0254	−2.1041	6.5633	0.0320	−1.4742
$State_{i,t}$	0.9117	0.0806	−2.9022	0.6134	0.2372	−0.4657	0.9117	0.0805	−2.9017
$CrossList_{i,t}$	0.6285	0.2336	−0.5319	0.1073	0.0958	2.5376	0.6285	0.2335	−0.5319

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