Directors' & Officers' liability insurance and financing decisions: Evidence from debt structure choice

WeiWei Li [a], Prasad Padmanabhan [b], Chia-Hsing Huang [a],*

[a] *SolBridge International School of Business, Daejeon, Republic of Korea*
[b] *Greehey School of Business, St. Mary's University, San Antonio, TX, USA*

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ABSTRACT

Using annual data for a group of Chinese listed firms over the 2010–2020 period, we investigate whether the purchase of Directors' and Officers' liability insurance alters the debt structure of Chinese firms, ceteris paribus. Using the two-stage least squares methodology, we find that such purchase persuades firm management to increase its long-term debt ratio, after controlling for several other factors that can influence this ratio. Several robustness tests reaffirm these findings. These results favor the monitoring effect theory over the moral hazard theory. The research results also show a significant negative correlation between the purchase of D&O Insurance and the cost of debt. The findings of this paper affirm the positive impact of buying D&O insurance on a listed firm's debt structure.

1. Introduction

There is extensive evidence documenting a positive relationship between firm value and the presence of directors/officers' liability insurance (D&O insurance) for public listed firms. These findings suggest that D&O insurance purchases can mitigate agency problems and managerial risk aversion (Holderness, 1990; Core, 1997; O'Sullivan, 1997). However, an equally impressive body of literature suggests that when firms purchase D&O insurance (where D&O insurers assume any losses associated with litigation against firm insiders), managers may be inclined to adopt risky projects which in turn can reduce firm value (Lin et al., 2013; Boyer and Tennyson, 2015; Liao et al., 2022; Chiang and Chang, 2022).

There is also another body of literature that examines the links between debt structure and a variety of managerial attributes. For example, the links between debt structure and managerial ownership (Datta et al., 2005), managerial compensation (Brockman et al., 2010; Fu et al., 2022), managerial overconfidence (Huang et al., 2016), managerial gender (Datta et al., 2021), managerial risk preference (Brockman et al., 2010), and external monitoring (Bathala et al., 1994) have been explored. However, the links between D&O insurance and debt structure have not yet been addressed. Can the purchase of D&O insurance persuade public listed firms to assume a higher proportion of long-term debt in their debt structure? Or will it motivate managers to lower the proportion of long-term debt in their debt structure since it incentivizes firm management to assume riskier projects, ceteris paribus? In addition will D&O insurance purchase alter the well-known relationships between managerial/institutional ownership levels and external debt, touted as explanations to reduce agency problems between managers and owners (Jensen and Meckling, 1976)? In this paper, the impact of the

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* Corresponding author.
E-mail addresses: wli218@student.solbridge.ac.kr (W. Li), ppadmanabhan1@stmarytx.edu (P. Padmanabhan), koreasing@solbridge.ac.kr (C.-H. Huang).

purchase of D&O insurance on the debt structure of the firm (and other relationships documented later) is explicitly examined.

These investigations garner theoretical support via the monitoring effect and the moral hazard theories. The monitoring effect theory suggests that if D&O insurers bear losses due to litigations against the firm, they would systematically monitor the firm's debt structure for increased financial risk (O'Sullivan, 1997; Yuan et al., 2016). One clear implication of such monitoring is that ceteris paribus, a firm will be persuaded to maintain a larger portion of long-term debt in its debt structure if they buy D&O insurance, since managers avoid litigation costs (paid by the D&O insurer). However, they can also be incentivized to undertake projects which maximize their own welfare at the expense of the welfare of the owners (i.e., can cause increases in agency costs to owners) by assuming more short-term debt to fund long term projects (Chen et al., 2016; Liao et al., 2022; Chiang and Chang, 2022) and is expected if the moral hazard theory holds.

To summarize, the primary focus of this study is to examine the impact of the purchase of D&O insurance on the debt structure using data from publicly listed Chinese firms over the 2010–2020 period. Banks may view short-term debt as enhancing their external monitoring opportunities during the short-term debt renewal processes and can mitigate agency costs caused by managerial discretion (Rajan and Winton, 1995; Stulz, 2001; Cheng et al., 2020). These monitoring activities may be particularly important in the Chinese market since listed firms still rely heavily on short-term debt (Wang et al., 2021a, 2021b) and/or face tightened financing constraints (Dethier et al., 2011; Cull et al., 2015). In addition, as a secondary focus, it is also of interest to examine the specific characteristics of firms who purchase D&O insurance and which in turn can influence the proportion of long-term debt held. Finally, D&O insurance may also impact the cost of debt of the firm.

The paper uses Chinese data to examine the main relationships of interest. Extant evidence indicates that approximately 90% of Hong Kong and Singapore firms purchase D&O insurance (Mai, 2010; Qian, 2020), while the penetration rates in Taiwan, US, and Canada are about 57%, 97%, and 86%, respectively(Zou et al., 2008; Lai and Tai, 2019). Curiously however, only 7.3% and 15% of Chinese listed companies purchased D&O insurance in 2018 and 2020, respectively (Li et al., 2022a).[1] Hence, this study also offers a unique opportunity to examine the impact of purchasing D&O insurance on the debt structure of listed Chinese firms. While there is extensive literature using Chinese data investigating the impact of D&O insurance purchases on price crash risk, corporate innovation and financial performance (Yuan et al., 2016; Li et al., 2022a), there is scant research examining the relationship between D&O insurance and the maturity structure of corporate debt. Hence, this research addresses this gap and aims to provide regulatory advice to governments on the implementation of D&O policies and practical advice to firms evaluating the purchase of D&O insurance.

Using data for a sample of 16,877 Chinese firms spanning the 2010–2020 period, the two-stage least squares method is utilized to examine the simultaneous decision involving leverage and debt maturity (Johnson, 2003; Datta et al., 2005; Datta et al., 2021). Results indicate that the presence of D&O insurance has a significantly positive relationship with long-term debt and suggest that the monitoring impact of D&O insurance persuades mangers to add more long-term debt (relative to firms with no such insurance) without any increase in financial risk. These results are reaffirmed by alternative tests (Heckman's (1979) two-stage model, alternative dependent variable tests, propensity score matching tests, placebo tests, instrumental variables two-stage least squares test, and the use of the Tobit regression model as an alternative test).[2]

Second, the specific characteristics of firms purchasing D&O insurance, and which affects the proportion of long-term debt held by the firm, are also examined. For instance, the magnitude of the positive relationship between D&O insurance and long-term debt is more pronounced for firms with higher levels of default risk, financial distress, asymmetric information, industry concentration, and for Big 4 audited firms. The magnitude of the positive D&O insurance/long-term debt relationship is also found to be smaller for firms with higher percentages of institutional ownership, higher fraction of shares held by the largest shareholder, and for firms with political connections. Third, results suggest that the purchase of D&O insurance also facilitates efficient monitoring of managers for firms in financial distress, with lower costs of debt, relative to firms who do not purchase such insurance. Finally, firms with long duration insurance coverage tend to hold higher levels of long-term debt. These additional results have not yet been reported in the literature.

The paper is organized as follows. In Section 2, we present a literature review and develop the various hypotheses, followed by data used, data sources and descriptions, and the presentation of the research methodology, in Section 3. Empirical results related to the relationship between D&O insurance purchase and the debt structure, several robustness and some other tests, are presented in Section 4. Conclusions, policy implications, and suggestions for further research in Section 5 round out the paper.

2. Rationale for the study, review of the literature and hypotheses development

2.1. D&O insurance, characteristics, and types of D&O insurance in China

Directors and Officers Liability Insurance (D&O Insurance) was first introduced in the United States in the 1930s with market maturity being gradually achieved by the late 1960s. The decision to purchase such coverage can be made by the corporate directors/executives of a firm.[3]

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[1] Possible rationales for the relative lack of interest to purchase D&O insurance by Chinese firms are discussed in Section 2.1.

[2] Additional robustness tests have been conducted to verify the major findings of the paper. Details of these additional tests are provided later in the paper (footnote 13).

[3] Such insurance can be purchased solely (or jointly) by the company and its directors and officers. This insurance coverage is responsible for bearing the legal expenses and civil compensation costs incurred during litigation against directors or executives due to personal negligence or improper conduct, thus serving as a third-party mechanism.

There are both positive and negative effects associated with the purchase of such insurance. On the plus side, the design mechanism of such insurance can enhance a firm's internal control protocols within the firm (Priest, 1986) and allow third-party insurance companies to independently monitor decisions made by firm management (Core, 2000). D&O insurance can also inhibit managerial pursuit of risky projects for personal gain and motivate managers to make rational firm-level decisions, which can enhance trust between managers and other stakeholders of the firm (Gutiérrez, 2003).

On the negative side, the protective effect of D&O insurance on corporate directors and executives may induce moral hazard issues (Bolton et al., 2006) and infringe upon the interests of minority shareholders (Zou et al., 2008) while allowing executives to pursue personal gains at the expense of other stakeholders.

Interest in the D&O market in China only emerged after several notices and opinions were issued in 2002 and beyond. For instance, the Supreme People's Court issued the "Notice on Relevant Issues Concerning the Acceptance of Civil Tort Cases Arising from Securities Market False Statements," in 2002 and which clarified the criteria for determining directors' civil liability in judicial practice. In addition, also in 2002, opinions (Guiding for Corporate Governance of Public Companies) were published (Meng et al., 2023). Next, in 2005, a revised "Company Law" established the shareholder representative litigation system and reduced investor borne costs of litigation against firm management (Zou et al., 2008). Subsequently, in 2006, an opinion (Opinions on Insurance Industry Reform and Development) focused attention on the need to develop efficient D&O protocols in China. Finally, in 2014, another opinion (Opinions on Accelerating the Development of the Modern Insurance Service Industry) aimed at modernizing the insurance industry in general in China (Wang et al., 2020).

These developments were instrumental in several Chinese firms seeking to purchase D&O insurance since 2002. However, these developments also illustrate the fact that the Chinese D&O insurance market is still in its infancy, whereas such markets have been in use for over 80 years in developed countries (Europe, the United States, Canada, and Japan).

Several institutional and other differences between the western markets and the Chinese market exist. These differences relate to differences in theoretical foundations, institutional backgrounds, the legal environment, market development levels, corporate governance mechanisms, cultural differences, and costs associated with D&O purchase and can influence D&O insurance penetration rates and associated costs of purchase in Chinese markets (Li et al., 2022a; AIG, 2017; Li et al., 2022a).[4] It is envisioned that as the market develops and purchase costs decrease, more of eligible Chinese firms will purchase these products.

While several studies (documented elsewhere in the paper) on developed markets exist and given the significant differences with respect to political systems, economic institutions and applicable laws and regulations between established D&O insurance markets and the Chinese markets, in this paper we explore the impact of D&O insurance on the debt maturity structure conceptually and empirically using Chinese data.[5] Results should be interest to both theoreticians, empiricists, and policy makers.

2.2. D&O insurance, managerial behavior, debt structure, and the cost of debt

Under the indemnity agreement, D&O insurance payments cover potential expenses of firm directors and officers arising from lawsuits by a third party. Litigation risks have increased in recent times because of increased managerial responsibilities placed on directors and officers.[6]

External lenders and institutions generally review firm level applications to renew short-term debt to ensure that it does not increase financial risks incurred by the firm. To avoid frequent (and costly) external monitoring (Datta et al., 2005), or to prevent denial of renewal of short-term debt (Von Thadden, 1995), managers may opt for increased levels of long-term debt. Since external monitoring ensures more frequent oversight of short-term debt (when compared to long-term debt), agency costs associated with financing options may be reduced (Rajan and Winton, 1995; Von Thadden, 1995). Therefore, the purchase of D&O insurance by a firm may be viewed externally as a corporate governance mechanism to induce directors and officers to make decisions that maximize the owners' value of the company (Denis and McConnell, 2003), to reduce management risk aversion towards corporate decisions and to mitigate agency problems (Holderness, 1990). Utilizing the *monitoring effect theory,* D&O insurance can potentially serve as another mechanism

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[4] As explained earlier, only a small fraction of eligible firms purchase any kind of D&O insurance in China. We speculate that possible reasons can include: the high cost of such insurance, the lack of familiarity with such insurance in China, possible cultural differences related to the reluctance of Asian societies to litigate in general, and that the market for D&O insurance only became viable since 2014. The current penetration rate in China is only 15% (2020 figures), while other countries enjoy strong penetration rates. For instance, Germany (a 77% penetration rate in 2008), and Taiwan (a 82.2% penetration rate in 2014, Lin et al., 2019; Huang et al., 2021) enjoy higher penetration rates presumably since they have been in existence for longer periods than in China and allowed for steady sequential developments in such markets. D&O insurance markets have been in existence since the 1930s in the US while they are in existence in the UK, Germany, Korea, and Taiwan since 1985 or later. Collective analysis of the D&O market development process indicates that the development and the regulation of the D&O markets is a long-drawn-out process.

[5] Different types of insurance provide varying degrees of coverage. Firms may decide to purchase insurance individually for each director or opt for comprehensive entity coverage. Clearly, the purchase of different types of insurance can affect the financial risks of the firm. Similarly, we agree that identifying specific vs. entity-based D&O purchase can make a difference to the financial risks of the firm, but data availability precludes a thorough examination of these important issues. We thank a referee for these important comments and leave this as a subject matter for further research as more data becomes available. While the focus of this paper in the impact of D&O insurance on debt maturity, we believe that the robust findings reported in this paper are important since they have not been reported elsewhere in the literature and enhances our understanding of the impact of D&O insurance on debt structure.

[6] Professional managers, employed when ownership and management are separated, could be problematic if each group's interests diverge (Jensen and Meckling, 1976).

that can reduce agency problems facing the firm (Core, 1997; O'Sullivan, 1997). The monitoring effect theory suggests that if D&O insurers bear losses due to litigations against the firm, they would systematically monitor the firm's debt structure for increased financial risk (O'Sullivan, 1997; Yuan et al., 2016). One clear implication of such monitoring is that ceteris paribus, a firm will be persuaded to maintain a larger portion of long-term debt in its debt structure if they buy D&O insurance, since managers avoid litigation costs (paid by the D&O insurer).

Hypothesis 1a.   Based on the monitoring effect theory, D&O insurance and long-term debt are expected to be positively related.

In contrast, the *moral hazard theory* suggests that managers of firms with D&O insurance can capture risky projects since they are now protected from personal monetary losses via litigation. Directors and officers may now be held less accountable for project outcomes and hence may be incentivized to adopt risky projects (Lin et al., 2013; Boyer and Tennyson, 2015) as well as risky financing options and investments (Bradley and Chen, 2011; Chen et al., 2016; Liao et al., 2022; (Li and Liao, 2014; Chiang and Chang, 2022). Such risky actions by managers may not maximize firm value (Winter, 1992). Managers may have incentives to undertake projects which maximize their own welfare at the expense of the welfare of the owners (i.e., can cause increases in agency costs to owners) by assuming more short-term debt to fund long term projects (Chen et al., 2016; Liao et al., 2022; Chiang and Chang, 2022) and is expected if the moral hazard theory holds.

Hypothesis 1b.   Based on the moral hazard theory, D&O insurance and long-term debt are expected to be negatively related.

The purchase of D&O insurance can reduce firm level default risks and costs of subsequent debt (the monitoring effect theory). In contrast, if moral hazard issues are present, the subsequent costs of debt can increase. Existing literature presents mixed results related to the purchase of D&O insurance and the cost of debt. For instance, Lin et al. (2013) show that D&O insurance and cost of debt have a positive relationship because managers may opt for riskier projects if D&O insurance is purchased due to moral hazard, while Li et al. (2022b) show that the purchase of such insurance can reduce firm level default risks leading to lower costs of subsequent debt.

Hypothesis 2a.   Based on the monitoring effect theory, the purchase of D&O insurance is negatively related to the cost of debt.

Hypothesis 2b.   Based on the moral hazard theory, the purchase of D&O insurance is positively related to the cost of debt.

2.3. D&O insurance, debt structure, and rationale for the study

In Section 2.2, arguments to link D&O insurance (via the monitoring effect and the moral hazard theories) to the debt structure of the firm were presented. The monitoring effect theory suggests that D&O insurance motivates firms to pursue more long-term debt while the moral hazard theory predicts that firm management are incentivized to increase financial risks and assume more short-term debt vs. long-term debt (Chen et al., 2016; Liao et al., 2022; Chiang and Chang, 2022). Given these conflicting predictions, empirical results will determine which of the two theories dominate in this context.

Hence, this paper examines the following questions: As the monitoring effect theory suggests, can the presence of D&O insurance increase the long-term component of the firm's debt structure relative to firms without such insurance? Or will the presence of D&O insurance decrease long-term debt structure (relative to firms with no such insurance), according to the moral hazard theory?

Second, several robustness checks to ensure the validity of the relationship of interest are conducted. Furthermore, some additional forces can also potentially influence the relationship of interest. The impacts of these forces are captured by the introduction of several additional control variables[7] to determine if the primary relationship – that between the purchase of D&O insurance and the long-term debt structure – remains inviolate in the presence of these additional control variables.

Third, as presented earlier, empirical evidence on the links between D&O insurance and the cost of debt are mixed. To possibly resolve this issue, the paper also investigates which of these competing forces better capture the links between D&O insurance and the cost of debt.

Finally, we investigate whether the covered *duration* (defined as the Directors and Officers liability insurance coverage period, i.e., the elapsed time since the initial purchase of such insurance) of D&O insurance has any impact on the debt structure. If the monitoring effect theory is valid, then the longer the period of covered duration, the more likely these firms would hold long term debt. Again, these issues are investigated in this paper.

3. Data, sources, and research methodology

This study includes all Chinese firms listed on the Shanghai and Shenzhen Stock Exchanges over the 2010–2020 (inclusive) period. However, financial firms were excluded from the study since their reporting rules and financial structures differ from those of non-financial companies. Next, firms with missing data on key variables were also excluded from the study. Finally, all continuous variables are winsorized at 1% and 99% to avoid extreme values.

The data on the purchase of D&O insurance are extracted from the Chinese Research Data Services database (CNRDS).[8] While the database presents information on Chinese firms purchasing such insurance, the process of purchasing such insurance is formalized in China. As outlined by Wang et al. (2023), purchase of D&O insurance must be approved by shareholders. In addition, although

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[7] These variables are presented and discussed later.
[8] http://www.cnrds.com

controlling shareholders are exempt from voting on the insurance purchase, they are still covered by such insurance. However, minority shareholders have been known to veto the purchase of such insurance for Chinese firms (Wang et al., 2023).

The corporate finance and governance data are obtained from the China Stock Market and Accounting Research (CSMAR) database.[9] The final sample contains 16,877 panel data points from 3216 firms.

Following the leads of Johnson (2003), Datta et al. (2005), and Datta et al. (2021), the two-stage least squares method is used to study the relationship between D&O insurance and corporate debt structure. Based on Barclay and Smith (1995), Johnson (2003), and Datta et al. (2021), firm level leverage and debt structure entertain a causal relationship. Therefore, in this paper, the expected leverage is estimated from the first stage of the regression, which then is used as an independent variable in the second stage (the dependent variable is the debt structure for the second stage) In the first stage, several factors (other than D&O Insurance) that influence a firm's leverage are used to extract expected leverage. Several other variables that explain debt structure are also used as independent variables in the second stage.

More specifically, the endogenous variable, leverage, is estimated in the first stage as shown in Eq. (1). Prior literature has documented the impact of several factors that can influence leverage and are used in the first stage to control for these established effects. For instance, firm size (defined as the natural log of total assets (Size), market to book ratio (MTB), fixed assets to total assets ratio (Fixed Asset), operating profit margin (Operating Profit), whether the firm has been audited by one of the big four accounting firms (Big 4), ROA volatility (ROA Volatility), managerial ownership (Managerial Ownership), industry fixed effect (γ_s), and year fixed effect (τ_t) are the control (independent) variables.[10]

$$
\begin{aligned}
Leverage_{it} = \alpha &+ \beta_1 Size_{it} + \beta_2 MTB_{it} + \beta_3 Fixed\ Asset_{it} + \beta_4\ Profit\ Margin_{it} + \beta_5 Big4_{it} + \beta_6 ROA\ Volatility_{it} \\
&+ \beta_7 Managerial\ Ownership_{it} + \gamma_s + \tau_t + \varepsilon_{it}
\end{aligned}
\tag{1}
$$

The estimated Leverage ($\widehat{Leverage}$) drops out of this equation as the best fit linear model. These estimates are now used in the second stage as one of the independent variables. Using US firms' data, the fraction of debt maturing in >3 years and the proportion of debt maturing in <3 years (or 5 years) are defined as long-term debt and short-term debt in Barclay et al. (2003) and Datta et al. (2021), respectively. However, because of the lack of detailed debt information for the Chinese sample, following Zheng et al. (2012), alternative measures of debt maturity, including DM1 and DM1b, are used in this study. DM1 is defined as long-term debt maturing in one year or later. DM1b is defined as DM1 plus bonds payable divided by total debt. To make sure that choice of debt maturity will not impact the baseline regression results, alternative measures of debt maturity are used to proxy for the usage of long-term debt. Here, the impact of the incidence of D&O insurance on the long-term debt ratio of the firm (defined as debt maturing in one year or later, long-term debt/total debt, *DM1*) is the dependent variable in the second stage of the regression (Eq. (2)).[11] One of the key independent variables in the second stage is captured by a dummy, D&O Insurance, which assumes a value of 1 if the firm purchases D&O liability insurance, and 0 otherwise. However, several additional independent variables are added to control for other factors that may potentially influence debt structure. For instance, size (natural logarithm of total assets (Size) and size^2 (natural logarithm of the square of total assets (Size^2), profit margin (Profit Margin), volatility of return on assets (ROA Volatility). Next, many firms may have a prior income tax loss carryforward benefit. This variable is introduced as Carryforward, a dummy variable, equal to 1 for firms with operating loss carryforwards, and 0 otherwise (Datta et al., 2019). Third, the dependent variable may be influenced by whether the Chief Executive Officer and the chairman are concurrently elected (1 if yes, 0 otherwise, Dual). Finally, still other variables that may affect the relationship of interest are: the number of board members (Board Size) (Berger et al., 1997); the % of shares owned by the managers, Managerial Ownership); whether the entity is a state-owned enterprises (SOE) (Hu and Fang, 2022); the % of shares owned by controlling shareholders (Controlling Ownership) (La Porta et al., 1999; Claessens et al., 2000; Amin and Liu, 2020); % of outstanding shares owned by institutional shareholders (Institutional Ownership) (Brown et al., 2019); whether the firm's auditors belong to one of the big four accounting firms (Big4); proportion of shares held by the largest shareholder (Largest) (Truong and Heaney, 2007; Bunkanwanicha et al., 2008; Gu et al., 2022; Chen et al., 2022); market to book ratio (MTB); whether the CEO possess an academic background (dummy, 1 if yes, and 0 if not, CEO Academic); regional marketization index (Marketization); whether the CEO is politically connected (dummy, 1 if yes, 0 if not), Political Connection); industry fixed effects (γ_s), and year fixed effects (τ_t) are the independent variables. Extant literature suggests that Profit Margin (Berger et al., 1997), Size (Berger et al., 1997; Zheng et al., 2012; Datta et al., 2019;), Dual (Xiao and Liao, 2008), MTB (Myers, 1977) have positive relationships with the long-term debt ratio. In addition, Carryforward (Datta et al., 2019), ROA Volatility (Dang and Phan, 2016; Fu et al., 2022), Board Size (Harford et al., 2008; Xiao and Liao, 2008), Managerial Ownership (Datta et al., 2005), Largest (Xiao and Liao, 2008), Marketization (Zheng et al., 2012) have negative relationships with the long-term debt ratio.

Next, managerial risk propensity may also be affected by the CEO's delta and vega scores. The CEO delta (CEO vega) measures the sensitivity of a CEO's wealth to changes in stock prices (stock price volatilities) (Lin et al., 2013). Because of the lack of detailed information on the delta and vega measures associated with sample firms, and following Jackson et al. (2008) and Fang (2009), executive compensation stickiness is used to measure the sensitivity of executive wealth to changes in stock prices. Executive

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[9] https://www.gtarsc.com

[10] All variables used in the paper are described in the Appendix.

[11] Another variable, DM1b is also used an alternate independent variable in separate regressions. DM1 is defined as long-term debt maturing in one year or later. DM1b is defined as DM1 plus bonds payable divided by total debt. Henceforth, when subsequent references are made to these variables in the paper, these definitions are used.

compensation (Compensation) and executive compensation stickiness (Compensation Stickiness) are also included as additional control variables. In addition, governmental regulatory policies can impact relationships between the purchase of D&O insurance and the cost of debt (Li et al., 2022b; Lin et al., 2013) and other variables. Next, host country regulatory forces can become especially important for multinational firms operating in many countries with different regulatory policies. Therefore, firm internationalization (Internationalization) is included as an additional control variable.

The final regression examined in the study is presented below:

$$
\begin{aligned}
DM_{it} = \alpha &+ \beta_1 D\&O\ Insurance_{it} + \beta_2 lnSize_{it} + \beta_3 ln^2 Size_{it} + \beta_4 Profit\ Margin_{it} + \beta_5 ROA\ Volatility_{it} + \beta_6 Carryforward_{it} \\
&+ \beta_7 Dual_{it} + \beta_8 Board\ Size_{it} + \beta_9 Managerial\ Ownership_{it} + \beta_{10} SOE_{it} + \beta_{11} Institutional\ Ownership_{it} + \beta_{12} Big4_{it} \\
&+ \beta_{13} Largest_{it} + + \beta_{14} MTB_{it} + + \beta_{15} Marketization_{it} + \beta_{16} Political\ Connection_{it} + \beta_{17} Internationalization_{it} \\
&+ \beta_{18} Compensation_{it} + \beta_{19} Compensation\ Stickiness_{it} + \beta_{20} \widehat{Leverage}_{it} + \gamma s + \gamma t + \varepsilon_{it}
\end{aligned}
\tag{2}
$$

3.1. Summary statistics

Summary statistics are shown in Table 1. For DM1, the mean and median values are 0.0779 and 0.0112, respectively. For DM1b, the corresponding values are 0.1100 and 0.0286, respectively. These values indicate that debt maturities are asymmetrically distributed, and the average proportion of long-term debt is small. From these statistics, one clear difference between firms holding D&O insurance and those who do not, emerges - sample firms with D&O insurance hold a significantly higher percentage of long-term debt (both DM1 and DM1b) when compared to firms that do not buy insurance. These preliminary results provide additional motivation to examine how the purchase of D&O insurance affects a firm's debt structure.

Next, Pearson correlation coefficients between all sample variables are presented in Table 2. Of particular importance for the research questions posed in this study is the correlation between debt maturity, D&O insurance, and each of the other variables examined in this study. A key observation is that DM1 and DM1b are significantly positively associated with the incidence of D&O insurance – firms with insurance are associated with higher debt structures. Finally, tests of multicollinearity between sample variables indicate no multicollinearity problems.[12]

4. Empirical results

4.1. Baseline regression models

In this section, the regression models presented in Eqs. (1) and (2) are examined to determine the relationship between D&O insurance and debt structure and are referred to as baseline results, the robustness of which are subject to additional scrutiny in subsequent sections. Results of runs involving DM1 and DM1b (the second stage regressions) are presented in Table 3, models 1 and 3 (dependent variable DM1) and DM1b (models 2 and 4). Models 3 and 4 contain the independent variables specified in Models 1 and 2, the additional industry fixed effects (γ_s), and the year fixed effects (τ_t) with standard errors clustered at firm level.

The results of Table 3 columns (1), (2), (3), and (4) show that D&O insurance and debt maturities (DM1 and DM1b) are significantly positively related and imply that firms with D&O insurance tend to have higher level of long-term debt. These results support Hypothesis 1a that D&O insurance and long-term debt have a positive relationship and provide evidence in support of the monitoring effect theory and against the moral hazard theory (rejection of Hypothesis 1b).

Next, the robustness of these results is examined further by using other tests presented later.

4.2. Robustness tests

From the results presented in Table 3, the D&O insurance variable is significantly positively correlated with the debt maturities (DM1 and DM1b). Clearly, these results demonstrate that if firms opt for D&O insurance, they are also those with higher percentages of long-term debt relative to those without such insurance. While these preliminary results favor the monitoring effect theory over the moral hazard theory, further tests to confirm the robustness of these results need to be conducted. To achieve this, several series of additional tests that include, the Heckman two stage tests (Section 4.2.1), the alternate dependent variable and propensity score matching tests (Section 4.2.2) are conducted. Results of some of these tests are presented below.[13]

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[12] Tests of multicollinearity indicate no serious problems. The Variance Inflation Factors (VIFs) for Managerial Ownership, Institutional Ownership, and MTB are respectively, 1.81, 1.80, and 1.01. Results of the multicollinearity runs are available upon request from the authors.

[13] Several additional robustness tests are conducted to ensure that the primary results are confirmed. These tests include several additional robustness tests, a monitoring effect test, and tests examining the relationship between D&O duration and the debt maturity structure. The additional robustness tests (the instrumental variable test, a placebo test, the Tobit model test, tests using additional control variables, and the lagged variables test), strongly reaffirm the baseline positive relationship between D&O insurance and long-term debt. The results of moderating effects analyses also show that the magnitude of the positive relationship between D&O insurance and long-term debt is more pronounced for firms with higher levels of default risks and for firms in financial distress. Firms with long duration insurance coverage also tend to hold higher levels of long-term debt. The detailed results associated with these additional tests are presented in the Online Appendix.

Table 1
Summary statistics for the full sample, and for subsamples of firms with D&O insurance and without D&O insurance.

Variables	Full sample			D&O Ins	Without D&O Ins	p-value of diff.
	Mean	Median	SD	Mean	Mean	
D&O Insurance	0.0711	0.0000	0.2570	–	–	–
DM1	0.0799	0.0112	0.1283	0.1247	0.0764	<0.001
DM1b	0.1100	0.0286	0.1569	0.1653	0.1058	<0.001
Size	22.1911	22.0229	1.2654	22.2555	20.1097	<0.001
Profit Margin	0.1242	0.1441	2.4414	0.1794	0.1200	0.208
ROA Volatility	0.0404	0.0170	0.5313	0.0391	0.0405	0.533
Board Size	8.4905	9.0000	1.6678	8.9626	8.4544	<0.001
Managerial Ownership	14.2685	1.2765	19.8454	3.9012	15.0621	<0.001
Intuitional Ownership	41.3331	42.9040	24.5968	54.9894	40.2876	<0.001
MTB	0.3369	0.3163	0.1638	0.3413	0.3366	0.171

Note: Variable definitions and units are presented in Appendix 1.

Table 2
Pearson correlations between debt maturity, D&O insurance and control variables.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
1) DM1	1											
2) DM1b	0.84	1										
(3) D&O Insurance	0.10	0.10	1									
(4) Size	0.31	0.36	0.23	1								
(5) Profit Margin	0.02	0.02	0.006	0.01	1							
(6) ROA Volatility	0.01	0.006	−0.001	−0.02	−0.01	1						
(7) Dual	−0.01	−0.08	−0.09	−0.15	0.003	−0.003	1					
(8) Board Size	0.11	0.11	0.08	0.25	0.01	−0.01	−0.17	1				
(9) Managerial Ownership	−0.18	−0.17	−0.14	−0.31	0.01	−0.01	0.21	−0.18	1			
(10) SOE	0.18	0.17	0.17	0.32	0.01	−0.01	−0.28	0.28	−0.46	1		
(11) Institutional Ownership	0.17	0.16	0.15	0.42	0.003	−0.01	−0.19	0.23	−0.67	0.42	1	
(12) MTB	−0.05	−0.02	0.01	0.06	0.03	−0.03	0.04	0.04	0.92	0.01	−0.06	1

Note: Variable definitions and units are presented in Appendix 1.

4.2.1. Heckman two-stage model

Another set of tests to ensure the robustness of results is the Heckman two stage tests. Clearly, the baseline model presented earlier may suffer from an endogeneity problem. In addition, as outlined by Datta et al., 2021, the Heckman's (1979) two-stage model can be used to avoid a potential selection bias problem. The first stage is a conditional logistic model to estimate the probability that the firm will have D&O insurance as a function of the percentage of companies with D&O Insurance in the industry (D&O Insurance %), Company Age, Current Ratio, SOE, Size, and Dual. The results of the first stage model are reported in Table 4.

$$D\&O\ Insurance_{it} = D\&O\ Insurance\%_{it} + Company\ Age_{it} + Current\ Ratio_{it} + SOE_{it} + Size_{it} + Dual_{it} \tag{3}$$

Next, the inverse Mills ratio (IMR) estimated from the first stage is now an independent variable (in addition to all the control variables introduced under Eq. (2)) in the second stage of the model. The revised equation tested under stage 2 in presented below as Eq. (4):

$$
\begin{aligned}
DM_{it} = {} & \alpha + \beta_1 D\&O\ Insurance_{it} + \beta_2 lnSize_{it} + \beta_3 ln^2 Size_{it} + \beta_4 Profit\ Margin_{it} + \beta_5 ROA\ Volatility_{it} + \beta_6 Carryforward_{it} \\
& + \beta_7 Dual_{it} + \beta_8 Board\ Size_{it} + \beta_9 Managerial\ Ownership_{it} + \beta_{10} SOE_{it} + \beta_{11} Institutional\ Ownership_{it} + \beta_{12} Big4_{it} \\
& + \beta_{13} Largest_{it} + {} + \beta_{14} MTB_{it} + {} + \beta_{15} Marketization_{it} + \beta_{16} Political\ Connection_{it} + \beta_{17} Internationalization_{it} \\
& + \beta_{18} Compensation_{it} + \beta_{19} Compensation\ Stickiness_{it} + \beta_{20} \widehat{Leverage}_{it} + \beta_{21} IMR_{it} + \gamma s + \gamma t + \varepsilon_{it}
\end{aligned}
\tag{4}
$$

The results of the second stage regression are presented in Table 5. Again, similar to the results presented earlier, the incidence of D&O insurance continues to remain significantly positively associated with both DM1 and DM1b. These results reaffirm support for the monitoring effect theory and suggest that self-selection biases do not affect the original baseline results. Next, additional tests to confirm the robustness of baseline model results are conducted in Section 4.2.2.

4.2.2. The alternate dependent variable and propensity score matching tests

If the monitoring effect theory is confirmed, then firms with D & O insurance must hold lower levels of short-term debt, ceteris paribus. In other words, one should expect a negative relationship between short term debt (relative to total firm debt) and the

Table 3
Relationships between D&O insurance and debt maturity: second stage of 2SLS regression results.

Variables	DM1	DM1b	DM1	DM1b
	Model 1	Model 2	Model 3	Model 4
D&O Insurance	0.0157***	0.0115**	0.0157**	0.0115**
	(0.0002)	(0.0171)	(0.0320)	(0.0421)
Size	0.0517**	0.1283***	0.0517	0.1283***
	(0.0250)	(0.0000)	(0.2166)	(0.0062)
$Size^2$	−0.0014***	−0.0028***	−0.0014	−0.0028***
	(0.0047)	(0.0000)	(0.1230)	(0.0079)
Profit Margin	0.0003	0.0004	0.0003	0.0004
	(0.1622)	(0.1427)	(0.1538)	(0.1407)
ROA Volatility	−0.0023*	−0.0031**	−0.0023	−0.0031*
	(0.0888)	(0.0357)	(0.1287)	(0.0582)
Carryforward	−0.0089**	−0.0086**	−0.0089**	−0.0086*
	(0.0104)	(0.0365)	(0.0238)	(0.0574)
Dual	−0.0013	0.0020	−0.0013	0.0020
	(0.5442)	(0.4598)	(0.6814)	(0.6151)
Board Size	−0.0010	−0.0021***	−0.0010	−0.0021
	(0.1469)	(0.0081)	(0.4488)	(0.1377)
Managerial Ownership	−0.0003***	−0.0004***	−0.0003***	−0.0004***
	(0.0000)	(0.0000)	(0.0081)	(0.0098)
SOE	−0.0048*	−0.0086***	−0.0048	−0.0086
	(0.0637)	(0.0057)	(0.3101)	(0.1253)
Institutional Ownership	−0.0002***	−0.0004***	−0.0002	−0.0004***
	(0.0086)	(0.0000)	(0.1310)	(0.0032)
Big4	−0.0001	0.0003	0.0034	0.0017
	(0.4098)	(0.9485)	(0.4061)	(0.7335)
Largest	−0.0001	−0.0001	−0.0001	−0.0001
	(0.4098)	(0.2745)	(0.6409)	(0.5136)
MTB	0.0725***	0.0728***	0.0725***	0.0728***
	(0.0000)	(0.0000)	(0.0004)	(0.0013)
Marketization	0.0029*	−0.0026***	−0.0031***	−0.0022***
	(0.0934)	(0.0000)	−0.0015	(0.0003)
Political connection	−0.0015	−0.0009	(0.6429)	−0.0009
	(0.4701)	(0.7286)	0.0029	(0.8179)
Internationalization	0.0029*	0.0063***	(0.3058)	0.0063*
	(0.0934)	(0.0033)	−0.0027	(0.0614)
Compensation	−0.0027*	−0.0025	(0.1857)	−0.0025
	(0.0556)	(0.1267)	0.0001	(0.2754)
Compensation stickiness	0.0001	0.0003*	(0.5519)	0.0003
	(0.3567)	(0.0842)	1.6183***	(0.2433)
$\widehat{Leverage}$	1.6183***	1.6513***	(0.0000)	1.6513***
	(0.0000)	(0.0000)	−0.4097	(0.0000)
_ cons	−0.4097	−1.4083***	(0.3843)	−1.4083***
	(0.1186)	(0.0000)	Yes	(0.0078)
Year & Industry	Yes	Yes	Yes	Yes
Cluster at firm level	No	No	Yes	Yes
N	12,635	12,635	12,635	12,635
adj. R^2	0.316	0.319	0.316	0.319

Notes: Models (1) and (3) are the results for the dependent variable, the percentage of debt maturing in one year or more (DM1). Models (2) and (4) show the results for the dependent variable, the percentage of debt due in one years or more plus bond payable (DM1b). The industry fixed effect (γ_s) and year fixed effect (τ_t) are added into the independent variables in model (3) and model (4). The *p*-value are reported in brackets. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 4
Heckman first stage test results.

Variables	D&O Insurance
D&O Insurance %	38.5391***
	(0.0059)
Company Age	0.0239***
	(0.0000)
Current Ratio	0.0124***
	(0.0006)
SOE	0.2542***
	(0.0000)
Size	0.2243***
	(0.0000)
Dual	−0.2363***
	(0.0000)
_cons	−7.9504***
	(0.0000)
Year	Yes
Industry	Yes
N	12,635
Pseudo. R^2	0.1565

Notes: Variable names have been defined earlier. *p*-value reported in brackets. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

incidence of D&O insurance. To examine the validity of this contention, an alternate dependent variable (instead of DM1 and DM1b), namely short-term debt[14] to total debt ratio, SDM defined as, $\frac{short-term\ debt}{total\ debt}$ is used.[15]

Next, and following Rosenbaum and Rubin (1983) and Datta et al. (2021), the propensity score matching method is used to examine any financial differences between firms with and without D&O insurance.[16] The matching sample method used involves a comparison in two stages. In the first stage, a logit model utilizing variables affecting the purchasing of D&O insurance is used to generate matching scores for sample firms for comparison purposes. Firms with D&O insurance are matched using propensity scores to find another firm with similar statistical characteristics on control variables but without D&O insurance. Finally, after testing for covariance balance, the matched sample is examined using the two-stage least square regression model.

The regression results using SDM as the dependent variable are presented in panel 1 of Table 6 and the propensity score results are presented in panel 2 of Table 6. First, the D&O insurance variable is significantly negatively correlated with SDM. Similarly, the propensity scores matching procedure results show that the relationship between D&O insurance and long-term debt is significantly positive. Both results confirm the main findings reported in Section 4.1 and support the monitoring effect theory with respect to the purchase of D&O insurance.

4.3. D&O insurance and the cost of debt

As discussed earlier, the purchase of D&O insurance can reduce firm level default risks and the cost of debt (the monitoring effect theory, Li et al., 2022b). In contrast, if moral hazard issues are present, the cost of debt can increase. (Lin et al. (2013). In this section, the impact of D&O purchases on the cost of debt is examined using sample data. The firm level cost of debt (Debt Cost) is computed as the total interest expense paid out by the firm as a fraction of total debt.

Results presented in Table 7 indicate the significant negative correlation between the purchase of D&O Insurance and the cost of debt and imply that the purchase of such insurance can lower the cost of debt. These results again document the importance of the monitoring function provided by the purchase of D&O insurance and reaffirm the baseline model results while supporting the monitoring effect theory (Hypothesis 2a) while discounting the moral hazard theory (Hypothesis 2b).

5. Conclusions, policy implications and suggestions for further research

Using annual data for a group of Chinese listed firms over the 2010–2020 period, we investigate whether the purchase of Directors' and Officers' liability insurance alters the debt structure of Chinese firms, ceteris paribus. Using the two-stage least squares methodology, we find that such purchase persuades firm management to increase its long-term debt structure ratio, after controlling for several other factors that can influence this ratio, and without increasing financial risk. Several alternate robustness tests strongly confirm these findings.

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[14] Defined as debt maturing in less than one year.
[15] The remaining independent variables are the same as presented under Eq. (2).
[16] The same control variables used earlier are also used here.

Table 5
Heckman second stage results.

Variables	DM1	DM1b
	Model 1	Model 2
D&O Insurance	0.0156***	0.0129***
	(0.0002)	(0.0074)
Size	0.0503**	0.1345***
	(0.0293)	(0.0000)
Size^2	−0.0014***	−0.0028***
	(0.0046)	(0.0000)
Profit Margin	0.0004	0.0004
	(0.1360)	(0.1361)
ROA Volatility	−0.0023	−0.0030**
	(0.1101)	(0.0400)
Carryforward	−0.0088**	−0.0085**
	(0.0110)	(0.0397)
Dual	−0.0001	−0.0014
	(0.9584)	(0.6600)
Board Size	−0.0011	−0.0022***
	(0.1311)	(0.0054)
Managerial Ownership	−0.0003***	−0.0004***
	(0.0001)	(0.0000)
SOE	−0.0072**	−0.0055
	(0.0244)	(0.1440)
Institutional Ownership	−0.0002**	−0.0004***
	(0.0142)	(0.0000)
Big4	0.0067	0.0104*
	(0.1629)	(0.0773)
Largest	−0.0001	−0.0001
	(0.4171)	(0.2357)
MTB	0.0712***	0.0726***
	(0.0000)	(0.0000)
Marketization	−0.0029***	−0.0023***
	(0.0000)	(0.0031)
Political connection	−0.0018	−0.0012
	(0.3756)	(0.6265)
Internationalization	0.0034**	0.0066***
	(0.0473)	(0.0020)
Compensation	−0.0023	−0.0022
	(0.1131)	(0.1833)
Compensation stickiness	0.0001	0.0003*
	(0.4045)	(0.0835)
$\widehat{Leverage}$	1.6084***	1.6438***
	(0.0000)	(0.0000)
IMR	−0.0062	0.0192**
	(0.4529)	(0.0404)
_cons	−0.3553	−1.5400***
	(0.1845)	(0.0000)
Year & Industry	Yes	Yes
N	12,635	12,635
adj. R^2	0.317	0.319

Notes: Variable names have been defined earlier. *p*-value reported in brackets. The results presented in this table indicate that in the second stage of the Heckman two stage test, D&O insurance is significantly positively associated with both DM1 and DM1b. These results suggest that self-selection biases did not affect the original results. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Next, results suggest that the magnitude of the positive relationship between D&O insurance and long-term debt is more pronounced for firms with higher levels of default risk, financial distress, asymmetric information, and industry concentration as well as for firms audited by a Big 4 auditor. The magnitude of the positive relationship between D&O insurance and long-term debt is also smaller for firms with higher percentages of institutional ownership, for firms with higher fraction of shares held by the largest shareholder, and for firms with political connections.

In addition, the purchase of D&O insurance also allows efficient monitoring of manager activities especially of firms in financial distress, and can lower the cost of debt, relative to firms who do not purchase such insurance. Finally, firms with long duration insurance coverage tend to hold higher levels of long-term debt.

The findings of this paper affirm the positive impact of buying D&O insurance on a listed firm's debt structure and support the monitoring effect theory and not the moral hazard theory. Further research may add value by designing a methodology to differentiate between the two effects. Finally, these findings are applicable to Chinese firms. Will these results hold true when data from other

Tables 6

Relationship between D&O insurance and debt maturity: alternate dependent variable test results (panel 1) and propensity score matching test results (panel 2).

Panel 1: Alternative dependent variable		Panel 2: Propensity score matching	
Variable: SDM		Variable:DM1	Variable:DM1b
D&O Insurance	−0.0032**	0.0170***	0.0135**
	(0.0231)	(0.0012)	(0.0265)
Size	0.3291***	0.0411	0.1347**
	(0.0000)	(0.3675)	(0.0157)
Size^2	−0.0077***	−0.0013	−0.0029**
	(0.0000)	(0.1802)	(0.0129)
Profit Margin	−0.0003*	0.0645***	0.1084***
	(0.0752)	(0.0080)	(0.0000)
ROA Volatility	−0.0075***	−0.0207	−0.0067
	(0.0000)	(0.2534)	(0.7541)
Carryforward	−0.0251***	−0.0077	−0.0214*
	(0.0000)	(0.4531)	(0.0522)
Dual	0.0085**	0.0019	0.0017
	(0.0315)	(0.7590)	(0.8334)
Board Size	0.0006	0.0010	−0.0001
	(0.5412)	(0.5220)	(0.9374)
Managerial Ownership	−0.0004***	−0.0004	−0.0002
	(0.0017)	(0.1327)	(0.5856)
SOE	−0.0259***	−0.0074	−0.0052
	(0.0000)	(0.2075)	(0.4636)
Institutional Ownership	−0.0006***	−0.0001	−0.0004**
	(0.0000)	(0.4647)	(0.0310)
Big4	−0.0224***	0.0060	0.0144
	(0.0010)	(0.4873)	(0.1427)
Largest	−0.0001	−0.0004**	−0.0007***
	(0.3498)	(0.0339)	(0.0018)
MTB	−0.0148	0.0891***	0.0687**
	(0.3857)	(0.0036)	(0.0388)
Marketization	0.0007	−0.0034**	−0.0042**
	(0.4561)	(0.0319)	(0.0227)
Political connection	−0.0043	−0.0052	0.0003
	(0.2066)	(0.3333)	(0.9564)
Internationalization	0.0154***	−0.0012	0.0044
	(0.0000)	(0.7674)	(0.3891)
Compensation	−0.0148***	−0.0026	−0.0046
	(0.0000)	(0.4928)	(0.2696)
Compensation stickiness	0.0001	0.0000	−0.0002
	(0.7471)	(0.8701)	(0.4906)
$\widehat{Leverage}$	1.3883***	1.7458***	1.6575***
	(0.0000)	(0.0000)	(0.0000)
_cons	−3.1169***	−0.2725	−1.4413**
	(0.0000)	(0.6129)	(0.0282)
Year & Industry	No	Yes	Yes
N	12,635	2369	2369
adj. R^2	0.134	0.385	0.422

Notes: Variable names have been defined earlier. *p*-value reported in brackets. Panel 1 presents results when the alternate dependent variable SDM, defined as $\frac{short - term\ debt}{total\ debt}$, is used to examine the relationships between D&O insurance and SDM. Panel 2 reports the results of the propensity score matching test. Both results confirm the main findings reported in Section 4.1 and support the monitoring effect theory with respect to the incidence of D&O insurance. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

Table 7
D&O insurance and debt cost (Interest expense/total debt) – test results.

	(1)
	Debt Cost
D&O Insurance	−0.0009*
	(0.0888)
Controls	Yes
_cons	0.2886***
	(0.0000)
Year & industry	Yes
N	12,635
adj. R^2	0.245

Notes: Variable names have been defined earlier. *p*-value reported in brackets. This table shows that D&O insurance has a significantly negative relationship with the cost of debt. ***, **, and * denote significance at 1%, 5%, and 10%, respectively.

country firms are examined? Do smaller firms also benefit from the purchase of D&O insurance? There is ample scope for further research along these lines. Policy wise, publicly listed firms reluctant to purchase D&O insurance may be persuaded to do so by the findings of this study. Government policy may also be directed at incentivizing publicly listed firms to purchase D&O insurance.

CRediT authorship contribution statement

WeiWei Li: Writing – original draft, Software, Methodology, Investigation, Formal analysis, Data curation, Conceptualization. **Prasad Padmanabhan:** Writing – review & editing, Writing – original draft, Project administration, Methodology, Formal analysis, Conceptualization. **Chia-Hsing Huang:** Writing – review & editing, Writing – original draft, Supervision, Methodology, Formal analysis, Conceptualization.

Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.pacfin.2023.102248.

Appendix

Definitions of variables

This section provides the variable definitions used in the analysis.
DM1: Percentage of debt maturing in one year or more divided by total debt.
DM1b: DM1 plus bonds payable divided by total debt.
ASY: According to Yu et al. (2012), the information asymmetry is derived from daily frequency trading data

$LR_{i,t} = -\frac{1}{D_{i,t}}\sum_{k=1}^{D_{i,t}} \sqrt{\frac{V_{i,t}(k)}{\lceil r_{i,t}(k) \rceil}}$ and $ILL_{i,t} = \frac{1}{D_{i,t}}\sum_{k=1}^{D_{i,t}} \sqrt{\frac{\lceil r_{i,t}(k) \rceil}{V_{i,t}(k)}}.$

Where $r_{i,t}(k)$ is the stock return for the kth trading day of firm i in year t, $V_{i,t}(k)$ is the daily volume, and $D_{i,t}$ the number of trading days in the year.

Yield Reversal Indicator for $GAM_{i,t} = |\gamma_{i,t}|$.

The coefficient of $\gamma_{i,t}$ is based on:

$$r_{i,t}^e(k) = \theta_{i,t} + \varphi_{i,t}r_{i,t}(k-1) + \gamma_{i,t}V_{i,t}(k-1)sign\left[r_{i,t}^e(k-1)\right] + \varepsilon_{i,t}(k)$$

Where $r_{i,t}^e(k) = r_{i,t}(k) - r_{m,t}(k)$ is the excess return, $r_{m,t}(k)$ is market capitalization as weighted market return.

We followed Bharath et al. (2009) to extract the first principal component of the original indicators and capture their common variance information, i.e., the component associated with asymmetric information (ASY).

Audit quality: Enterprise audited by 'Big Four 'accounting firm assigned 1, otherwise 0.
Board Size: Number of Board members. (Berger et al., 1997).
Big4: Enterprise audited by 'Big Four 'accounting firm assigned 1, otherwise 0.
Carryforward: tax loss carryforward. Firms with operating loss carryforwards =1, otherwise 0.
Current Ratio: $\frac{Current\ liabilities}{Current\ assets}$.
Confucianism: The natural logarithm of the number of Jinshi plus 1 within 300 km of the listed company. (Kong et al., 2023) (Chinese Research Data Services Database)

Company Age: number of listed years

Compensation: Natural logarithm of executive Compensation.

Compensation stickiness: According to Jackson et al. (2008) and Fang (2009).

Controlling Ownership: controlling shareholders' ownership (La Porta et al., 1999; Claessens et al., 2000; Amin and Liu, 2020)

Debt cost: Interest expense/total liability

D&O Insurance %: The percentage of companies with D&O Insurance in the industry.

D&O Insurance duration: Directors and Officers Liability Insurance Coverage period (elapsed time since the initial purchase of such insurance).

D&O Insurance Industry-Year Mean: The average D&O insurance of all firms in the same industry and year excluding the focal firm.

Dual: Chief Executive Officer and the Chairman are concurrently elected =1, otherwise 0.

Default risk: According to Bharath and Shumway (2008).

Fixed Asset Ratio: Fixed Asset divided by total asset.

Independ Director Ratio: The number of independent directors divided by board size.

Internationalization: The number of overseas investment countries. (Zhang et al., 2021)

INS: Firm buying insurance liability (= 1if they do, 0 otherwise).

Institutional Ownership: Percentage of share owned by institutional investors (Brown et al., 2019)

Largest: the proportion of shares owned by the largest shareholder

Leverage: Long term debt divided by market value of total assets.

Lerner: According to Lerner (1995).

Managerial Ownership: the proportion of shares owned by the managers

Marketization: Regional marketization index (Wang and Fan, 2004)

MTB: Market to book ratio.

Profit Margin: (Net profit + income tax expenses + financial expenses + depreciation of fixed assets, depreciation of oil and gas assets, depreciation of productive biological assets + amortization of intangible assets + amortization of long-term amortized expenses)/Total Revenue

ROA Volatility: standard deviation of net income / total asset from t-2 to t year

Political Connection: If either of the chairman or CEO is a current or former government official = 1, otherwise 0. (Arifin et al., 2020)

SDM: short-term debt (debts of less than one-year maturity) to total debt ratio

Size: Natural logarithm of total assets.

Size^2: The square of natural logarithm of total assets.

SOE: State-owned enterprises dummy, SOE=1, 0 otherwise (Hu and Fang, 2022).

Z-value: $1.2 \times \frac{Working\ Capital}{Total\ Assets} + 1.4 \times \frac{Retained\ Earnings}{Total\ Assets} + 3.3 \times \frac{Earnings\ Before\ Interest\ and\ Taxes}{Total\ Assets} + 0.6 \times \frac{Market\ Value\ of\ Equity}{Book\ Value\ of\ Long-term\ Debt} + \frac{Net\ Sales}{Total\ Assets}$

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