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Why do firms purchase directors and officers liability insurance? – a perspective from short selling threats

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ABSTRACT

This study examines the role of increased short selling threats in firms' directors and officers liability insurance (D&O insurance) purchase decision against the backdrop of the Chinese deregulation of short sale. Using a difference-in-differences (DiD) research design, we demonstrate a positive effect of short selling threats on firms' likelihood of purchasing D&O insurance policies after controlling for the known determinants of D&O insurance. We then perform tests to validate the DiD analysis result, including a test of the parallel trend assumption and placebo tests. To shed light on the mechanism through which the effect of short selling takes place, we perform a path analysis. The results reveal that firms' litigation risk explains the effect of short selling pressure on D&O insurance purchase decision. Further cross-sectional analyses show that the positive effect of short selling threats on D&O insurance is ameliorated when firms have strong internal control or have great analyst coverage.

1. Introduction

Directors and Officers liability insurance (D&O insurance hereafter) is a type of insurance purchased by a firm to shield its directors and officers (D&Os) from personal liability that may arise from lawsuits brought by stakeholders (e.g. shareholders and creditors) alleging wrongdoings by D&Os while executing their duties. Extant literature on D&O insurance has provided rich – yet controversial – evidence on the impact of D&O insurance on managerial decisions, demonstrating either beneficial or detrimental effects on financial reporting quality, tax reporting, auditing, cost of equity, and firm value, among others (e.g. Boyer and Tennyson 2015; Chan et al. 2019; Li and Liao 2014; Lin et al. 2013; Wang et al. 2020). Relative to the studies on the consequences of D&O insurance, why firms commit to D&O insurance is less understood. A burgeoning literature identifies a few factors shaping firms' decision to purchase D&O insurance including increased litigation risk and significant agency conflicts between shareholders and managers (Park 2018; Zou et al. 2008), political connections (Jia, Mao, and Yuan 2019), and managerial overconfidence (Lai and Tai 2019). Extending this stream of literature on the motivating factors underlying D&Os seeking D&O insurance, we aim to examine a hitherto unanswered research question; namely, whether firms are more likely to purchase D&O liability insurance with an increase in short selling pressure within the capital market.

Short sellers create profit using a 'selling-high-and-buying-low' trading strategy at security markets, in that they borrow the shares from a broker and sell at a high price. When the share price later drops, the short sellers repurchase and return the shares to the broker from whom they had originally borrowed. The transaction only occurs when short sellers believe the share price will fall in the future. The current literature on short selling is fruitful, providing voluminous research on the role of short sellers in gathering and disseminating information,

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as well as providing evidence on short selling's real effects on shaping managerial decisions and financial reporting quality (see (Jiang, Habib, and Hasan 2022) for a comprehensive literature review). In line with the stream of literature examining how short selling shapes corporate decisions, our study focuses on whether short selling pressure influences a given firm's decision to purchase D&O insurance.

Our empirical inquiry is motived by tension suggested by short selling and D&O insurance literature. One the one hand, we posit that short selling may threaten D&Os with great risks of falling share price and firm value; thereby, short selling possibility is positively related with the likelihood of firms purchasing D&O insurance for the following reason. To make arbitrage gains, short sellers actively seek and reveal negative information about the firms they follow, which often cause substantial decline in stock price (Aitken et al. 1998). As a result of a sharp decline in shareholders' value, disgruntled shareholders may initiate lawsuits against D&Os or impose pressure on board of directors to replace members of their management team. When faced with the prospect of litigation and scrutiny from shareholders as a result of short-selling activities, risk-averse D&Os have strong incentives to request D&O insurance – the litigation risk hypothesis. Studying the D&O insurance purchased by IPO firms in Taiwan, Kao, Chen, and Krishnamurti (2020) found that firms purchase D&O insurance to mitigate litigation risk associated with issuing IPOs.

On the other hand, short selling disciplines manager's decisions making as observed by extant literature. Firms being followed by short sellers tend to refrain from earnings management (Fang, Huang, and Karpoff 2016; Jiang, Qin, and Bai 2020; Massa, Zhang, and Zhang 2015), opportunistic related party transactions (Jiang, Tian, and Zhou 2021), and enhance merger and acquisition performance (Chang, Lin, and Ma 2019). Following this line of argument, firms being followed by short sellers may have low level of information risk and superior long term firm performance, which may be associated with a low demand on D&O insurance by managers.

Our research is also motivated by the recency of corporates' adoption of D&O insurance in emerging markets, although D&O insurance has gained popularity and importance as a corporate governance mechanism for public firms in developed countries (Yuan, Sun, and Cao 2016). Due to the lack of databases with readily available data, research on D&O insurance requires manual data collection, which has restricted empirical investigations. A survey of the literature reveals relatively few studies on D&O insurance concentrated in countries such as Canada (e.g. Chung, Hillegeist, and Wynn 2015; Lin et al. 2013; Lin, Officer, and Zou 2011), Taiwan (e.g. Chan et al. 2019; Chang and Chen 2018; Chen and Keung 2018; Lai and Tai 2019), Korea (Hwang and Kim 2018; Park 2018), and the U. S (Donelson, Hopkins, and Yust 2018; Lin et al. 2020). As a comparatively new phenomenon, Chinese firms have increasingly adopted D&O insurance in recent years.[1] Owing to the availability of D&O insurance data, China is an important testing ground for identifying the determinants and consequences of the insurance (e.g. Jia, Mao, and Yuan 2019; Wang et al. 2020; Zou et al. 2008). New evidence on the D&O insurance from emerging markets would be a valuable addition to the international literature, whose focus is currently largely limited to developed markets.

Chinese government takes a gradual yet persistent approach to lifting bans on short selling in China. Starting in 2010, the Chinese Securities Regulatory Commission (CSRC) has been selecting eligible stocks to be shorted on the secondary securities markets, resulting in the number of shortable stocks increasing from 96 to 1738 between 2010 and 2019. In contrast to the Regulation SHO Pilot Program in the U.S., which removes the short-sale restriction on selected stocks for only a brief period and thereafter re-imposes the ban, the CSRC's effort to support the short-selling activities in China may impart a lasting effect on firms' decision-making. In this context, we examine a heretofore unexplored research question; namely, whether short-selling pressure prompts firms to purchase D&O insurance.

Importantly, the staggered deregulation of short selling in China resembles a quasi-experiment as the deregulation comes as an exogenous shock to one group of firms but not to other groups; thereby, such a setting allows us to offer evidence on whether a sudden increase in short-selling pressure induces firms to adopt D&O insurance policies using a difference-in-differences (DiD) research design. The DiD test also effectively eliminates the possibility that other unobservable firm characteristics could influence the purchase of D&O insurance while simultaneously attracting short-selling interest of a firm's stocks.

Utilizing a newly established database on D&O insurance information related to listed Chinese firms, our baseline regression analysis using data over the sample period of 2010–2019 confirmed that short-selling pressure is positively associated with the likelihood of firms purchasing D&O insurance policies. To validate our

DiD research findings, we conduct a test to check the parallel trend assumption and placebo tests. The results of the analyses confirm the appropriateness of our DiD research design.

To shed light onto the mechanisms underlying the effect of short selling threat on firms' undertaking of D&O insurance, a path analysis was performed. The results suggest that litigation risk is the channel via which the effect of short selling takes place, in that greater litigation risk in the presence of short selling explains D&O insurance purchase decision. Furthermore, the cross-sectional analyses demonstrate that the positive effect of short selling exposure on D&O insurance is mitigated when firms have strong internal control or high analyst coverage. Thus, our findings suggest that firms are less concerned about short-selling threats when they have established strong internal control and have existing market monitoring from financial analysts.

Although we main regression estimations are based on a DiD research design which alleviates the concerns for endogeneity, we conduct a few robustness tests, including using a regression where the variable of interest is a short selling ratio and a Generalized Method of Moment (GMM) estimation. The findings are consistent with the results of the DiD tests.

Our paper makes contributions to the literature mainly in two ways. Firstly, to our best of our knowledge, our paper is the first to examine whether short-selling interest, as a market trading mechanism, affects firms' insurance-purchasing decisions. Although studied on short selling have yielded rich evidence on the short sellers' information roles in the capital market, the literature on the interplay between short selling and corporate managerial decision-making is relatively young and continues to evolve (Jiang, Habib, and Hasan 2022). It is important to extend our knowledge about whether and how secondary stock market mechanisms shape managerial decisions (Goldstein and Guembel 2008); thus, in the context of short selling, our study is a meaningful addition to this emerging literature. Secondly, despite the rich evidence on the consequences of D&O insurance, little is known about the determinants of the purchase of the insurance. A few studies examining the determinants of D&O insurance purchase decisions have mainly focused on firms' characteristics, such as industry affiliation and corporate governance features (e.g. Park 2018; Jia, Mao, and Yuan 2019). In contrast, our study focuses on how short selling, as an external market mechanism, shapes firms' decisions to purchase D&O insurance, shedding light on the drivers of firms' commitment to D&O insurance. The remainder of the paper is organized as follows. Section 2 discusses the related literature and develops the testable hypotheses. Section 3 describes the research design. Section 4 presents the empirical results with a batch of robustness tests. Section 5 summarizes the contributions and discusses the implications of the results.

2. Literature review and hypotheses development

Since the 1980s, D&O insurance has been gaining popularity in developed markets, such as those of the U.S. and Canada. The insurance provides protection to D&Os from potential loss of wealth in the case of litigation, shifts the risk of claims against the D&Os to the insurance company, lowers the transaction costs of bankruptcy, and provides claim administration service efficiencies (Lai and Tai 2019). The literature suggests that during issuance of the insurance, the insurer carries out their due diligence, thereby serving as alternative monitors to detect or deter opportunistic managerial actions (Baker and Griffith 2007; Cao and Narayanamoorthy 2014). The premium charged by the issuer on the insurance reflects their assessment of a firm's litigation risks – particularly the risks related to financial reporting problems (Boyer and Tennyson 2015; Cao and Narayanamoorthy 2014).[2]

Empirical research has mainly focused on the consequence of D&O insurance, such as its effect on firms' innovation (Wang et al. 2020), investment efficiency (Li and Liao 2014), risk taking (Boyer and Tennyson 2015; Su, Jiang, and Tian 2020), acquisition outcome (Lin, Officer, and Zou 2011), financial reporting quality (Chang and Chen 2018; Chung and Wynn 2008; Weng, Chen, and Chi 2017), auditing (Lin et al. 2020), audit pricing (Chung, Hillegeist, and Wynn 2015), firms' IPO pricing (Kao, Chen, and Krishnamurti 2020), cost of equity (Chen, Li, and Zou 2016), and firm value (Hwang and Kim 2018), among others. Among studies on the consequences of D&O insurance, some identify the benefits, such as increasing D&Os' tolerance for risk taking and innovation (Su, Jiang, and Tian 2020; Wang et al. 2020; Su, Wu, and Lu 2022), reducing stock price crash risk and the likelihood of restatement (Yuan, Sun, and Cao 2016). However, others show that purchase of D&O insurance undermines the deterrent effect of litigation, leading to moral hazard problems (Baker and Griffith 2010; Chalmers, Dann, and Harford 2002; Li and Liao 2014; Wang and Chen 2016; Jia and Tang 2018; Chung

and Wynn 2008; Cao and Narayanamoorthy 2011) that are detrimental to shareholders' value in various ways (Lin, Officer, and Zou 2011; Lin et al. 2013; Chen, Kadapakkam, and Yang 2016).

Relative to the studies on the consequences of the D&O insurance, few studies have examined why firms take on the D&O insurance. This small pocket of literature has identified a few explanatory factors for firms' D&O insurance purchase decision, including increased litigation risk, high agency conflicts between managers and shareholders, and corporate governance features (e.g. Park 2018; Jia, Mao, and Yuan 2019; Su and Jiang 2022). Diverging from these studies, we focus on short selling as an external market trading mechanism and posit that it shapes firms' decision to purchase D&O insurance, based on the following reasonings.

First, short selling has strong implications for firms' litigation risk. Short sellers profit from the drops in share prices; therefore, they are vigilant about and actively seek out negative news about their target shares (e.g. Akbas, Boehmer, and Erturk 2016; Bris, Goetzmann, and Zhu 2007). In the presence of short selling interest, firms' negative news becomes exposed more rapidly and share prices incorporate negative information more quickly (e.g. Bris, Goetzmann, and Zhu 2007). The revelation of negative news about firms may result in a 'torpedo effect' on a firm's share price; that is, news of negative earnings can cause a disproportionately large stock price decline – the torpedo effect (Skinner and Sloan 2002). This is in accordance with short selling signaling immediate bad news, leading to a price plunge (Aitken et al. 1998). Share price crash may result in dissatisfied shareholders and increased litigation risks, while high litigation risk is a precursor of firms' purchasing decision of D&O insurance (Park 2018). As a result, short selling and firms' litigation risks indeed go hand in hand. Blau and Tew (2014) study the relationship between short selling and class actions using a sample of securities-related class-action lawsuits that were filed for violations of security acts in the U.S. They find that short activity surges in the days before the filing and remains significantly high a few days after the filing. They also report that short activity during the filing period increases the likelihood that the lawsuit eventually generates money for the plaintiff resulting in the stocks' financial losses.

Second, studies to date suggest that managers are aware of short selling interests and modify their decisions accordingly to avoid possible share price penalties (Massa, Zhang, and Zhang 2015; Fang, Huang, and Karpoff 2016; Chang, Lin, and Ma 2019; Luo, Ni, and Tian 2020; Jiang, Qin, and Bai 2020). Additionally, Bennett and Wang (2018) and Kunzmann and Meier (2018) show that short selling increased the likelihood of forced CEO turnover, either through the revelation of negative information or through the manipulation of stock prices. Collectively, extant literature suggests that short selling creates threats to firms, which may induce D&Os' request on D&O insurance to protect them from potential litigation risks.

The Chinese short selling market is regulated, as only designated securities are eligible for short selling (Chang, Cheng, and Yu 2007). Short sales were banned in mainland China until 31 March 2010, when the short selling deregulation scheme started, it permitted designated stocks to engage in short selling in China's A-share markets gradually. Since then, short-selling activities have been increasing (Jin et al. 2018). Adopting a gradual approach, the CSRC adds a batch of shortable stocks to the shortable stock list each year. Studies using Chinese short selling data provide corroborative evidence on short sellers' role in information discovery and on the effectiveness of their disciplinary functions. For instance, Chang, Luo, and Ren (2014) find that stocks' price efficiency has been improved when they are added to the shortable stock list. Similarly, Chen, Kadapakkam, and Yang (2016) report a positive association between the degree of information efficiency of stock prices and the intensity of short selling. With respect to the disciplinary functions of short selling, Hu et al. (2020) report that firms whose stocks become shortable experience a decrease in cost of equity, earnings management, and an increase in market liquidity and investment efficiency. Facing the prospect of short selling, firms significantly increase conditional accounting conservatism (Jin et al. 2018). When they are followed by great short selling interest, firms are more likely to engage in corporate philanthropic (CP) activities to divert attention from firms' negative information to more positive information (Hou et al. 2019). A recent study by Jiang, Tian, and Zhou (2021) find that short selling pressure as a result of the short selling deregulation in China encourages firms to conduct beneficial and related party transactions, but restrains them from transactions that are detrimental to shareholders' wealth.

Whether short selling impacts a given firm's decision to purchase D&O insurance also depends on the perception and effectiveness of D&O insurance at protecting directors and managers from the legal actions of market participants. In China, Article 111 of the Securities Law (revised in 2005) provides shareholders and

other stakeholders substance and procedures for seeking civil damages against directors and managers of a public firm who can be proven to be responsible for corporate misconduct (Jia, Mao, and Yuan 2019). The litigation risks and securities lawsuits against the directors and managers of a number of high-profile listed firms in China over recent years[3] have cost directors and managers momentary loss, resulting in adverse effects on executive compensation and to a great probability of subsequent managerial/director turnover (Jia, Mao, and Yuan 2019). Given the increasing civil liability lawsuits against directors and managers, the use of D&O insurance has gained popularity among the listed Chinese firms. The purchase of D&O insurance is also encouraged by Article 39 of the Code of Corporate Governance, which states that listed firms can purchase D&O insurance for their D&Os to protect their personal assets in the event of a lawsuit. Since the first batch of D&O insurance policies in 2002, the number of listed Chinese firms subscribing to the insurance has reached just over 300 in 2019.

Recent litigation risks in the stock market in China motivates firms to seek legal protection in the form of D&O insurance. A few studies have examined D&O insurance in China, providing insights into the determinants and consequences of D&O insurance. Zou et al. (2008) find that controlling-minority shareholder conflicts in China drives the purchase of D&O insurance. Controlling and minority shareholders have stronger conflicts when there are more representatives of large shareholders on the board of directors, and when firms engage in earnings management and/or tunnel firms' resources by conducting related-party transactions (Farooq et al. 2022). Jia, Mao, and Yuan (2019) report that firms with political connections are less likely to purchase D&O insurance, because political connections alleviate the firm's concern for litigation risks. Yuan, Sun, and Cao (2016) found a negative effect of D&O insurance on stock price crash risk, fewer financial restatements, and increased disclosure of corporate social responsibility reports, suggesting a conducive effect of D&O insurance on corporate governance. Taken together, we have seen a surge of D&O insurance subscriptions among listed firms.

Short sellers can identify various 'red flags' of corporate governance issues of the stocks they follow (Blau et al. 2013; Chi, Pincus, and Teoh 2014; Jain, Jain, and Rezaee 2016). They trade and reveal the negative information about the stock resulting in a plunge in the stock price (Aitken et al. 1998), which augments the litigation risk (Park 2018). Bennett and Wang (2018) and Kunzmann and Meier (2018) examined the impact of short selling on CEO turnover in the U.S. and find that short-selling threats increased the probability of forced turnover. Due to the threats generated by short selling, managers may take actions to hedge their personal risks. Firms purchase D&O insurance in response to increased litigation risk (Park 2018). In line with this reasoning, D&Os may request firms to purchase them the liability insurance to hedge potential risk associated with short selling pressure. The staggered deregulation of short selling in China introduced from 2010 resembles a quasi-experiment providing a setting for us to examine whether the sudden increase in short-selling pressure induces firms to adopt D&O insurance policies.

Nevertheless, we are aware of the possibility that, in response to heightened short selling pressure, firms may refrain from opportunistic corporate decisions (Massa, Zhang, and Zhang 2015; Fang, Huang, and Karpoff 2016; Chang, Lin, and Ma 2019; Jiang, Qin, and Bai 2020; Jiang, Tian, and Zhou 2021), which may contribute to low information risk and superior firm performance lowering the demand on D&O insurance. Despite this countervailing argument, the empirical findings on the heightened risk in the presence of short selling pressure pinpoints a positive impact of short selling on D&O insurance purchase decision, Hence, we develop Hypothesis 1, as stated in below.

Hypothesis 1. Firms exposed to short selling are more likely to purchase D&O insurance compared to firms without short-selling exposure.

It is also reported that firms with high agency conflicts purchase D&O insurance, and the D&O insurance premium reflects the quality of the firm's corporate governance, in that a large D&O insurance premium is positively associated with weak governance (Core 2000; Gillan and Panasian 2015; Park 2018). Chen and Keung (2018) show that firms with excess DOL insurance coverage demonstrate a greater likelihood of internal control weakness. Therefore, we would expect that firms being threatened with more short-selling interests intend to purchase D&O insurance, especially when the firm has weak internal control and great agency conflicts. On the contrary, the positive effect of short selling on the decision to purchase D&O insurance may be mitigated in cases in which firms have strong internal control. Taken together, the following testable hypothesis is developed:

Hypothesis 2. The positive effect of short selling exposure on firms' D&O insurance purchase decision is weakened in firms with strong internal control.

We are also interested in whether the eternal monitoring imposed by financial analysts can mitigate the positive effect of short selling on the purchase decision of D&O insurance. In addition to their information intermediary role, financial analysts have important governance functions (Jensen and Meckling 1976). Moyer, Chatfield, and Sisneros (2009) report that the monitoring imposed by analysts serve as an efficient mechanism to abate agency-related costs associated with debt and equity and to meet the information demands of investors. Due to monitoring roles played by financial analysts, firms followed by more analysts have relatively few agency conflicts (Jensen and Meckling 1976). Firms followed by more analysts may have a relatively good governance structure and less D&O concerns about litigation risks. Hence, we argue that, to the extent that the short sellers' threat to detect a firm's suboptimal governance and 'bad news' results in great litigation risk and triggers the purchase of D&O insurance, great analyst coverage may mitigate the impact. Given this argument, we develop the following hypothesis:

Hypothesis 3. The positive effect of short selling exposure on firms' D&O insurance purchase decision is mitigated in firms with great coverage by financial analysts.

3. Research design

3.1. Empirical model

CSRC lifted short selling restrictions on a list of selected firms at the CSRC's discretion. This staggered deregulation imposed by the regulator on individual firms is akin to a quasi-experiment, affecting the selected firms (treatment firms), but not others (control firms). This allows us to use a DiD research design to test whether a sudden increase in short-selling pressure induces firms to take on D&O insurance policies. Following the approach of Beck, Levine, and Levkov (2010), we use a staggered DiD research design regressing D&O insurance (DOI) on short selling exposure (ShortSell) and a set of control variables as described in Equation (1) to test Hypothesis 1.

$$DOI = \beta_0 + \beta_1 ShortSell + \beta_2 Size + \beta_3 Lev + \beta_4 TQ + \beta_5 ROA + \beta_6 Age + \beta_7 Risk + \beta_8 Cash + \beta_9 Qratio$$
$$+ \beta_{10} SOE + \beta_{11} Share + \beta_{12} Board + \beta_{13} Ind + \beta_{14} Sep + \beta_{15} Opin + \beta_{16} Big10 \tag{1}$$

where DOI is a dummy variable taking the value of 1 if the firm purchases the D&O insurance for their D&Os within the financial year. Short-selling exposure (ShortSell), measured as a dummy variable, in that a value of 1 is assigned to firms with shortable shares after the firms' shares became shortable, and 0 is assigned to their early years when shares were not shortable. In contrast, 0 is assigned to firm-year observations for firms with shares that have never become shortable over our sample period.[4] As suggested by Baker, Larcker, and Wang (2022), we ensure our control firms to be those that have never been identified shortable by the CSRC.

Following prior studies and considering the Chinese context, we control for an array of firms' characteristics that could determine firms' insurance purchase decision. First, following Lin et al. (2019) and Park (2018), we consider several business risk proxies including firm size (Size), leverage (Lev), Tobin's Q (TQ), profitability (ROA), firm age (Age), stock return volatility (Risk), cash holding (Cash), and short-term financial stability (Oratio). Meanwhile, since agency conflicts between managers and shareholders and corporate governance affect the D&O insurance purchase decision (e.g. Core 2000; Park 2018; Jia, Mao, and Yuan 2019), we control for a set of control variables to capture firms' characteristics of corporate governance, including state-ownership (SOE), ownership concentration (Share), board size (Board), independent directors (Ind), and control-ownership divergence (Sep). We also control for audit opinion (Opion) and audit quality (Big10) following Lin et al. (2019). Audit opinion captures auditors' perception of client risks, and quality auditors, proxied by Big 10 auditors in China, bear more reputation costs and are more likely to suggest their clients to purchase the insurance. We provide detailed definitions of these variables in the Appendix.

To test Hypothesis 2 and Hypothesis 3, we include the interactive term, ShortSell∗IC and ShortSell∗Analyst one at a time into Equation (1) to examine whether the effect of ShortSell on the D&O insurance purchase

decision varies with the strength of firms' internal control (Hypothesis 2) or analyst following (Hypothesis 3). The strength of internal control (*IC*) is measured using the Dibo internal control index. The Dibo internal control database is widely used by Chinese research on internal controls (e.g. Jiang, Tian, and Zhou 2021; Jiang and Chen 2019). The index ranges from 1 to 10, and the higher the score, the sounder a firm's internal control. Analyst coverage (*Analyst*) is the natural logarithm of the number of analysts following a firm. The main regressions used to test hypotheses are conducted using a logistic model. To draw causal inferences about the short-selling effect and to overcome the concern for endogeneity, we conducted additional analyses with various techniques, as described in the later sections.

3.2. Sample selection and descriptive statistics

Our sample is based on all shares listed on the Chinese A-share market. The sample period is from 2010 to 2019. The sample period starts from 2010 after the global financial crisis to ensure that the purchase of D&O insurance is not a contingent reaction to the global finance crisis. As shown in Panel A of Table 1, our initial sample had 21,652 observations. We first deleted 7995 observations from growth enterprise market (GEM) and Small and Median Enterprises (SME) listing boards, and then excluded 1258 and 527 observations of B-shares and financial firms. After deleting a further 1062 observations due to missing data for measuring variables, we retained 10,810 observations for analysis.[5] Among those, 950 firm-year observations had D&O insurance, and 9860 observations did not. Panel B of Table 1 shows the industry distribution of sample firms, revealing that the machinery, equipment, and instrument industry accounts for 17.13% of the total sample observations, followed by the petroleum, chemical and rubber, and metal and non-metal industries, with 9.22% and 8.55% of sample observations, respectively. Firms' financial and corporate governance information are retrieved from the China Stock Market and Accounting Research (CSMAR) database. The last column of Table 1, Panel B shows that the percentage of observations with D&O insurance varies according to industry throughout the sample period. The statistics suggest that 'F: Transportation and Storage' has the most firm-year observations with the D&O insurance, being followed by 'B: Mining and Quarrying' as well as 'C3: Papermaking and Printing.

The D&O insurance is normally renewed and paid on a yearly basis. Firms may decide to hold the insurance over a few years after they purchase the insurance. We then summarized the numbers of firms holding the insurance for various numbers of years within our sample period. We report the statistics in Table 1, Panel C. In addition, although most firms do not disclose the insurance premium, we have identified a few firms with public announcements containing information on premiums and the coverage. For those firms identified, they pay an approximately 100,000–300,000 RMB annual premium to cover their top executives (directors on the supervisory board and general board) without identifying the names of the insured. The maximum amount of indemnity insured is approximately 50–150 million RMB.

Panel A of Table 2 presents the descriptive statistics of the dependent variable (*DOI*), variable of interest (*ShortSell*), and other control variables. The table shows that approximately 8.8% of sample observations have D&O insurance *(DOI)* in their financial year; *Roughly, 38% of firm-year observations are shortable*. On average, liability accounts for approximately 50% of total assets (*Lev*), and the return on assets (*ROA*) is 3.67%. In addition, there are 60% observations from state-owned enterprises (*SOE*). Top shareholders hold, on average, 37% of shares (*Share*). The board is comprised of approximately 37% independent directors (*Ind*), and 60% of firms are audited by top 10 auditors (*Big10*). *Lend*, the ratio of lendable shares to outstanding shares, has a small average value because our sample includes all firm-year observations with and without short-selling interests.

The Pearson correlation matrix presented in Panel B of Table 2 shows that *DOI* and *ShortSell* are positively correlated (0.005), and this correlation was statistically significant. In addition, *DOI* is positively associated with *Size*, *Lev*, *Age*, *SOE*, *Share*, *Board*, *Ind*, *Sep*, *Big10*, and *Lend*, while *DOI* is negatively associated with *TQ*, *ROA*, *Cash*, and *Oratio*. Therefore, the correlation matrix supports the selection of the control variables, given that majority of the variables are significantly associated with the decision to purchase D&O insurance. Although the correlation coefficient between *DOI* and *Lend* suggests a positive relationship between one another, the caveat of univariate analysis is its lack of control for other firm characteristics. Therefore, multivariate regression analyses are then performed.

Table 1. Sample selection and industry distribution.

Panel A: Sample selection

Selection process	Observations
Initial observations for listed firm on SSE and SZSE over the period 2010–2019	21,652
Less: GEM and SME board observations	(7,995)
Less: B-share observations	(1,258)
Less: financial companies' observations	(527)
Less: observations without sufficient data for variables measurement	(1,062)
A-share firm-year observations (1,732 firms)	10,810

Panel B: Sample distribution by industry

Industry	Observations	Percentage (%)	Insurance holders (%)
A: Farming, Forestry, Animal Husbandry & Fishery	180	1.67	0.05
B: Mining & Quarrying	416	3.85	0.1683
C0: Food and Beverage	530	4.90	0.0509
C1: Textile, Clothing & Fur	346	3.20	0.0405
C3: Papermaking & Printing	193	1.79	0.1658
C4: Petroleum, Chemical, Rubber & Plastic	997	9.22	0.0742
C5: Electronic	357	3.30	0.0644
C6: Metal & Non-metal	924	8.55	0.0963
C7: Machinery & Equipment. Instrument	1852	17.13	0.0658
C8: Medicine & Biologic Products	710	6.57	0.0775
D: Production, Supply of Power, Gas & Water	505	4.67	0.0832
E: Construction	253	2.34	0.1146
F: Transportation & Storage	499	4.62	0.2004
G: Information Technology Industry	617	5.71	0.0470
H: Wholesale & Retail Trades	765	7.08	0.1216
J: Real Estate	727	6.73	0.0880
K: Social Services	420	3.89	0.1000
L: Transmitting & Culture Industry	190	1.76	0.0842
M: Integrated	329	3.04	0.0608
Full sample	10810	100	0.0879

Panel C: Basic statistics of firms having the D&O insurance

Renewed period	Numberof holders	Total sample firms
Holding $>$ $=$ 1 years	164	–
Holding $>$ $=$ 2 years	142	–
Holding $>$ $=$ 3 years	120	–
Holding $>$ $=$ 4 years	107	–
Holding $>$ $=$ 5 years	95	–
Holding $>$ $=$ 6 years	78	–
Holding $>$ $=$ 7 years	63	–
Holding $>$ $=$ 8 years	45	–
Holding $>$ $=$ 9 years	36	–
Holding $>$ $=$ 10 years	31	–
Firms holding the insurance	164	1732

4. Regression results

4.1. Short selling exposure and D&O insurance

We estimate Equation (1) as our baseline regression using as a Probit model where we regress *DOI* on *ShortSell* and other control variables following a staggered DiD research design.[6] Table 3 presents the results. As reported in column (1), we estimate the regression without controlling for any control variables, while column (2) shows the estimation results controlling for all controls. Both model specifications control for firm and year fixed effect. The findings show that the coefficients on short selling exposure (*ShortSell*) is significantly positive (coefficients 1.3871 and 1.5652, z statistics 3.5149 and 2.1390, $p < 0.01$ and 0.05, respectively), suggesting that firms are more likely to purchase D&O insurance for their DOs after their shares become shortable.

Table 2. Descriptive statistics and correlation matrix.

Panel A: Descriptive statistics

Variable	N	Mean	Median	SD	Min	Max
DOI	10810	0.0879	0.0000	0.2831	0.0000	1.0000
ShortSell	10810	0.3823	0.0000	0.4860	0.0000	1.0000
Size	10810	21.8952	21.7811	1.5725	12.3272	28.6927
Lev	10810	0.4993	0.5030	0.1990	0.1098	0.8760
TQ	10810	1.9068	1.5410	1.0689	0.0000	5.7979
ROA	10810	0.0367	0.0321	0.0487	−0.1190	0.1631
Age	10810	2.5156	2.7601	0.7099	0.3167	3.2297
Risk	10810	0.0671	0.0574	0.0827	0.0121	5.0662
Cash	10810	0.1637	0.1356	0.1134	0.0001	0.9148
Qratio	10810	1.2806	0.9064	1.2564	0.1570	7.9015
SOE	10810	0.6039	1.0000	0.4891	0.0000	1.0000
Share	10810	0.3668	0.3482	0.1575	0.0220	0.8941
Board	10810	2.1795	2.1972	0.2018	1.0986	2.8904
Ind	10810	0.3714	0.3333	0.0569	0.0909	0.8000
Sep	10810	0.4867	0.0000	0.4998	0.0000	1.0000
Opin	10810	0.9674	1.0000	0.1775	0.0000	1.0000
Big10	10810	0.6004	1.0000	0.4898	0.0000	1.0000
Lend	10810	0.0010	0.0000	0.0132	0.0000	0.4264

Panel B: Pearson correlation analysis

	DOI	ShortSell	Size	Lev	TQ	ROA	Age	Risk	Cash	Qratio	SOE	Share	Board	Ind	Sep	Opin	Big10	Lend
DOI	1																	
ShortSell	0.005***	1																
Size	0.196***	0.114***	1															
Lev	0.105***	0.026***	0.362***	1														
TQ	−0.081***	−0.047***	−0.457***	−0.283***	1													
ROA	−0.034***	0.009	0.105***	−0.413***	0.116***	1												
Age	0.097***	−0.074***	0.058***	0.236***	0.087***	−0.223***	1											
Risk	−0.038	−0.013	−0.097***	−0.014	0.095***	0.019**	−0.119***	1										
Cash	−0.041***	−0.032***	−0.042***	−0.270***	0.155***	0.237***	−0.129***	0.028***	1									
Qratio	−0.069***	−0.025***	−0.264***	−0.657***	0.216***	0.292***	−0.259***	0.047***	0.449***	1								
SOE	0.124***	0.034***	0.263***	0.190***	−0.159***	−0.135***	0.274***	−0.083***	−0.042***	−0.185***	1							
Share	0.024**	0.051***	0.289***	0.031***	−0.169***	0.140***	−0.215***	0.012	0.035***	0.003	0.203***	1						
Board	0.059***	0.034***	0.209***	0.114***	−0.097***	−0.004	0.028***	−0.040***	−0.037***	−0.103***	0.207***	0.018*	1					
Ind	0.019**	0.011	0.086***	0.028***	−0.030***	−0.024***	−0.031***	−0.007	0.019**	0.007	−0.009	0.049***	−0.417***	1				
Sep	0.062***	0.048***	0.103***	0.047***	−0.092***	−0.020**	−0.056***	−0.021**	−0.002	−0.040***	0.432***	0.107***	0.046***	0.062***	1			
Opin	0.013	0.013	0.142***	−0.118***	−0.123***	0.236***	−0.078***	−0.015	0.067***	0.057***	0.052***	0.088***	−0.009	0.008	0.040***	1		
Big10	0.078***	0.056***	0.181***	0.021**	−0.082***	0.039***	−0.081***	0.002	−0.017*	−0.020**	0.050***	0.124***	0.047***	0.036***	−0.006	0.037***	1	
Lend	0.081***	0.096***	0.114***	0.026***	−0.047***	0.009	−0.074***	−0.013	−0.032***	−0.025***	0.034***	0.051***	0.034***	0.011	0.048***	0.013	0.056***	1

Note: The definitions and measurements of the variables are presented in Table 1. ***, **, and * represent significance levels of 1%, 5%, and 10%, respectively. Variables are Winsorized at the 1% level.

Table 3. Baseline regression using a difference-in-differences (DiD) research design.

	DOI	
	(1)	(2)
ShortSell	1.3871∗∗∗	1.5652∗∗
	(3.5149)	(2.1390)
Size		0.9375∗∗∗
		(2.9022)
Lev		7.8037∗∗∗
		(2.7497)
TQ		0.4141
		(1.4385)
ROA		2.8758
		(0.7511)
Age		−1.5973
		(−1.1332)
Risk		1.6272∗∗∗
		(4.9325)
Cash		−4.9614∗∗∗
		(−2.6635)
Qratio		−0.1690
		(−0.8056)
SOE		9.6322∗∗∗
		(5.1056)
Share		5.2080
		(1.1153)
Board		10.7940∗∗∗
		(5.7866)
Ind		14.2075∗∗∗
		(3.7499)
Sep		6.3495∗∗∗
		(6.5306)
Opin		0.6522
		(0.9733)
Big10		1.2240∗∗
		(2.0323)
Constant	0.9674	−12.1535
	(1.5874)	(−1.5653)
Firm FE	Yes	Yes
Year FE	No	Yes
Pseudo R^2	0.2164	0.3451
Chi2	159.50∗∗∗	884.14∗∗∗
N	10810	10810

The coefficients of the control variables are also consistent with the expectation in general. We find that firms are more likely to purchase D&O insurance when they are large (*Size*), more leveraged (*Lev*), have great stock return volatility (*Risk*), stated-owned (*SOE*), have a large board (Board) and more independent directors (*Ind*), have a large disparity between voting and cash flow rights (Sep), or are audited by Big10 auditors (*Big10*). Nevertheless, it is unlikely for firms to purchase D&O insurance when they have more cash (*Cash*). In summary, our baseline results are consistent with the view that short-selling deregulation imposes pressure on firms, and that firms purchase D&O insurance accordingly, to hedge the risks associated with the short-selling exposure.

4.2. Validation on the DiD research design

The DiD test shows the short selling deregulation prompts firms to purchase D&O insurance. Then, we conduct a few sensitivity tests to validate the finding of the DiD research design. First, a crucial assumption of the DiD analysis is that firms selected for short sell by the regulator (treatment sample) and those that are not selected (control sample) have parallel trends before the 'shock', and the difference is only shown afterward. To validate the underlying parallel trend assumption, we regress the *DOI* on a set of time dummies covering the years pre and post the short shorting deregulation. The results reported in Table 4 Panel A corroborate the parallel trend

Table 4. Tests to validate the DiD research design.

Panel A: Validity test of the parallel trend assumption	
	DOI
	(1)
$ShortSell_{i,t-9}$	0.2047
	(0.3574)
$ShortSell_{i,t-8}$	0.3958
	(0.8206)
$ShortSell_{i,t-7}$	0.4698
	(1.4243)
$ShortSell_{i,t-6}$	−0.3310
	(−1.1080)
$ShortSell_{i,t-5}$	0.4793
	(1.4437)
$ShortSell_{i,t-4}$	0.3350
	(1.4844)
$ShortSell_{i,t-3}$	−0.3047
	(−1.5451)
$ShortSell_{i,t-2}$	0.2338
	(1.3279)
$ShortSell_{i,t-1}$	0.1478
	(1.0852)
$ShortSell_{i,t}$	0.3556***
	(3.8388)
$ShortSell_{i,t+1}$	0.4296***
	(4.4433)
$ShortSell_{i,t+2}$	0.4059***
	(4.0567)
$ShortSell_{i,t+3}$	0.4264***
	(4.1368)
$ShortSell_{i,t+4}$	0.4123***
	(4.0261)
$ShortSell_{i,t+5}$	0.3786***
	(3.6641)
$ShortSell_{i,t+6}$	0.3714***
	(3.4960)
$ShortSell_{i,t+7}$	0.3572***
	(3.2899)
$ShortSell_{i,t+8}$	0.4651***
	(4.0710)
$ShortSell_{i,t+9}$	0.3745***
	(2.8801)
Size	0.2456***
	(13.9199)
Lev	0.4211***
	(2.6299)
TQ	0.0763***
	(3.2278)
ROA	−1.2084**
	(−2.3347)
Age	0.3444***
	(7.7451)
Risk	3.5625***
	(3.3339)
Cash	−0.2723
	(−1.2665)
Qratio	0.0574**
	(2.2381)
SOE	0.1806***
	(3.4582)
Share	−0.5341***
	(−4.0809)

(*continued*).

Table 4. Continued.

Panel A: Validity test of the parallel trend assumption	
Board	0.1183
	(1.2275)
Ind	0.1373
	(0.4345)
Sep	0.0837**
	(2.0837)
Opin	0.0804
	(0.6609)
Big10	0.1781***
	(4.5105)
Constant	−8.1839***
	(−16.8496)
Firm FE	Yes
Year FE	Yes
Pseudo R²	0.3340
Chi2	736.51***
N	10810

Panel B: Placebo tests			
	DOI		
	(1) t-1	(2) t-2	(3) t-3
ShortSell_Pseudo	1.7437	1.6688	1.5031
	(1.4743)	(1.4299)	(1.4725)
Size	0.9537***	0.9537***	0.9216***
	(3.0435)	(2.9465)	(2.8554)
Lev	7.1136***	6.7299**	6.7929***
	(2.8724)	(2.5527)	(2.6591)
TQ	0.2851	0.3818	0.3972
	(0.9339)	(1.2553)	(1.2838)
ROA	3.2580	3.0691	2.7861
	(0.8508)	(0.7629)	(0.7105)
Age	−1.1257	−1.2076	−1.2507
	(−0.8629)	(−0.9019)	(−0.9499)
Risk	1.4885***	1.4059***	1.5902***
	(4.6388)	(4.3226)	(4.7971)
Cash	−4.0901*	−4.2095*	−3.9724*
	(−1.7604)	(−1.7564)	(−1.7915)
Qratio	−0.0128	0.0164	0.0167
	(−0.0624)	(0.0757)	(0.0768)
SOE	9.4229***	9.7486***	9.6678***
	(5.2096)	(5.1111)	(5.0101)
Share	5.1444	5.2586	5.1844
	(1.1353)	(1.1145)	(1.0989)
Board	10.3198***	10.5002***	10.3851***
	(5.2927)	(5.3228)	(5.4377)
Ind	13.8188***	13.9429***	13.8982***
	(3.3292)	(3.3226)	(3.3809)
Sep	6.2067***	6.3916***	6.4080***
	(6.4703)	(6.2715)	(6.4020)
Opin	0.8420	0.8097	0.8488
	(1.2548)	(1.1856)	(1.2720)
Big10	1.1160*	1.3119**	1.2824**
	(1.8061)	(2.3283)	(2.2861)
Constant	−11.4533	−12.7265	−12.9818*
	(−1.5182)	(−1.6398)	(−1.6626)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Pseudo R²	0.3457	0.3436	0.3432
Chi2	794.59***	725.07***	670.47***
N	10810	10810	10810

assumption, demonstrating significantly positive coefficients on the years after firms are exposed to short selling pressure ($ShortSell_{i,t}$, $ShortSell_{i,t+1}$, ..., $ShortSell_{i,t+9}$). The results seem to be persistent post the deregulation.

In addition, we conduct placebo tests to further assess the sensitivity of our DiD research design. We perform three placebo tests setting the first, second, and third year before the actual deregulation year as the pseudo-shock year and then rerun our DiD test using Equation (1). In the absence of an actual shock, we expect the treatment and control samples to exhibit no difference in the effect of *ShortSell_Pseudo* on the disclosure of customer information. The results, reported in Panel B of Table 4, show that the coefficients on *ShortSell_Pseudo* are no longer significant, which confirms that our results are due to the deregulation of short selling rather than other events in the same time periods.[7]

4.3. Why does short selling effect take place – the channel analysis

As supported by prior studies, firms purchase D&O insurance in the face of heightened litigation risk (Park 2018). Also, the greater a firm's litigation risk, the greater the premium the issuer charges the firm (Boyer and Tennyson 2015; Cao and Narayanamoorthy 2014). Meanwhile, short selling exposes firms' 'bad news', which may trigger negative market reactions, thereby increasing a firm's litigation risk. For instance, Blau and Tew (2014) find that short activity surges in the days before shareholders filing securities-related class-action lawsuits and remains significantly high a few days after the filing. They also report that short activity during the filing period increases the likelihood that the lawsuit eventually generates money for the plaintiff resulting in the stocks' financial losses. Therefore, we examined whether our finding of the positive effect of short selling pressure on the insurance purchase decision occurs via its effect on firms' litigation risk. To test whether the litigation risk is the underlying mechanism through which short selling exposure affects D&O insurance, we conducted a path analysis, following Baron and Kenny (1986).

Baron and Kenny (1986) contend that a mediation effect presents when the following three conditions are met: (1) path A: variations in the proposed independent variable, *ShortSell*, account significantly for variations in the dependent variable (*DOI* in our baseline Equation (1) below); (2) path B: variations in the levels of the independent variable (*ShortSell*) account for variations in the proposed mediator significantly (i.e. *litigation risk*, *Lit_Risk*) (Equation (2) below); and (3) path C: the significant relationship between *ShortSell* and *DOI* becomes insignificant once paths A and B are controlled (full mediation), or the significant relationship is reduced once paths A and B are controlled (partial mediation) (Equation (3) below). The set of equations for the mediation tests is as follows:

$$DOI = \beta_0 + \beta_1 ShortSell + \sum Controls + \sum Industry + \sum Year + \varepsilon_{i,t} \tag{2}$$

$$Lit\_Risk = \alpha_0 + \alpha_1 ShortSell + \sum Controls + \sum Industry + \sum Year + \varepsilon_{i,t} \tag{3}$$

$$DOI = \gamma_0 + \gamma_1 ShortSell + \gamma2 Lit\_Risk + \sum Controls + \sum Industry + \sum Year + \varepsilon_{i,t} \tag{4}$$

We estimated the above equation and reported the results in Table 5. Column (1) shows the regression results of Equation (1) – the same as was reported in Table 3, column (2). Column (2) of Table 5 suggests that *ShortSell* is positively associated with litigation risk (*Lit_Risk*), as expected based on short selling literature. Column (3) shows that the significant relationship between *Lend* and *DOI* is reduced after paths A and B are controlled for – the coefficient on *ShortSell*, γ_1, is 1.719 (z statistic 2.3069) in comparison to $\beta_1 =1.5652$ (z statistic 2.1390) in column (1). Hence, the findings suggest that the litigation risk (*Lit_Risk*) has a partial mediating effect, and they explain some of the effect of the short selling (*ShortSell*) on the insurance purchase decision (*DOI*).

Path coefficient γ_1 is the magnitude of the direct path from *ShortSell* to *DOI*. The path coefficient α_1 is the magnitude of the path coefficient from *ShortSell* to *Lit_Risk*. The path coefficient $\gamma2$ is the magnitude of the path from *Lit_Risk* to D&O insurance purchase (*DOI*). Overall, path coefficient $\alpha_1 \times \gamma2$ measures the magnitude of the indirect path from *Lend* to *DOI* mediated by *Lit_Risk*. Using the results in columns (2) and (3), we calculated $\alpha_1 \times \gamma2 = 0.0512 \times 2.8067 = 0.1437$. The Sobel test z-statistic, which tests the null hypothesis that $\alpha_1 \times \gamma2 = 0$, is statistically significant (z = 3.794, $p < 0.01$), thereby rejecting the null hypothesis. The finding suggests that *ShortSell* on *DOI* is partially mediated by litigation risk (*Lit_Risk*), and this mediating effect is significant.

Table 5. Why does short selling effect take place? – Path analysis of the mediating effect of litigation risk on the association between short selling and D&O insurance purchase.

	DOI (1)	Lit_Risk (2)	DOI (3)
ShortSell	1.5652∗∗	0.0512∗∗	1.1719∗∗
	(2.1390)	(2.3394)	(2.3069)
Lit_Risk			2.8067∗∗∗
			(6.1292)
Size	0.9375∗∗∗	−0.0996∗∗	1.3324∗∗
	(2.9022)	(−2.1065)	(2.4560)
Lev	7.8037∗∗∗	0.6801∗∗	10.1945∗∗∗
	(2.7497)	(2.3524)	(3.2444)
TQ	0.4141	0.0785∗∗	0.5075
	(1.4385)	(2.0937)	(1.5754)
ROA	2.8758	1.8656∗∗∗	0.0907
	(0.7511)	(2.8774)	(0.0170)
Age	−1.5973	0.2564	−2.8142∗∗
	(−1.1332)	(1.1051)	(−2.2206)
Risk	1.6272∗∗∗	0.5398∗∗∗	1.8557∗∗∗
	(4.9325)	(3.1708)	(4.3607)
Cash	−4.9614∗∗∗	−0.7737∗∗	−2.5352∗∗
	(−2.6635)	(−2.0334)	(−2.0828)
Qratio	−0.1690	0.0671	−0.0768
	(−0.8056)	(1.2796)	(−0.2573)
SOE	9.6322∗∗∗	0.4378∗∗	11.7126∗∗∗
	(5.1056)	(2.3990)	(5.2526)
Share	5.2080	−0.5322	2.2993
	(1.1153)	(−1.3030)	(0.4095)
Board	10.7940∗∗∗	−0.3184	14.3670∗∗∗
	(5.7866)	(−1.2857)	(6.1605)
Ind	14.2075∗∗∗	−1.2509∗	21.6050∗∗∗
	(3.7499)	(−1.8446)	(4.0983)
Sep	6.3495∗∗∗	0.0946	8.0265∗∗∗
	(6.5306)	(0.8539)	(6.8083)
Opin	0.6522	−0.1829	0.3397
	(0.9733)	(−1.3563)	(0.5315)
Big10	1.2240∗∗	0.0315	1.7441∗∗∗
	(2.0323)	(0.4170)	(2.8126)
Constant	−12.1535	0.5762	−13.9839
	(−1.5653)	(0.4593)	(−1.4568)
Firm FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes
Pseudo R^2	0.3451	0.3621	0.3657
Chi2	884.14∗∗∗	209.95∗∗∗	887.43∗∗∗
Z-statistic of Sobel test			3.794∗∗∗
N	10810	10810	10810

Note: Standard errors are clustered by firm. All variables are winsorized at the bottom and top 1% points of their empirical distributions.

Therefore, the finding provides a plausible explanation for the observed positive effect of short-selling pressure on the insurance purchase decision.

4.4. Cross-sectional analysis

This section describes two cross-sectional tests that are performed to examine the moderating effect of internal control and analyst coverage on the association between short selling exposure and D&O insurance purchase decision, as predicted in Hypothesis 2 and Hypothesis 3. To test Hypothesis 2, we expand Equation (1) to include the standalone variables internal control (*IC*) and the interactive term, *ShortSell* × *IC*. We then perform the logistic estimation using Equation (1), and the results are shown in Table 6 Column (1). To test Hypothesis 3, we repeat the same procedure with analyst coverage (*Analyst*), and the results are shown in Column (2) of Table 6. The results reported in Column (1) show a significantly negative coefficient on *ShortSell* × *IC*, indicating that the

Table 6. Cross-sectional analysis on the moderating effect of internal control and financial analysts.

	DOI (1)	DOI (2)
ShortSell	2.2895**	1.6422**
	(2.0742)	(2.0929)
ShortSell *IC	−1.3757**	
	(−2.1035)	
IC	0.7683	
	(0.9416)	
ShortSell*Analyst		−0.3777**
		(−2.0795)
Analyst		1.9502
		(1.3765)
Size	0.8832***	1.1502**
	(2.6713)	(2.2800)
Lev	7.7189***	9.6464***
	(2.7690)	(2.9564)
TQ	0.3822	0.3403
	(1.2904)	(1.0472)
ROA	2.9472	5.0171
	(0.7717)	(0.9830)
Age	−1.7338	−0.3237
	(−1.1496)	(−0.2065)
Risk	1.5480***	2.1737***
	(4.9474)	(4.4056)
Cash	−4.6542**	−6.3497***
	(−2.3320)	(−3.5112)
Qratio	−0.1438	−0.1012
	(−0.6341)	(−0.3175)
SOE	9.4950***	11.5081***
	(5.0384)	(5.3332)
Share	5.3137	5.244*
	(1.0510)	(1.1201)
Board	10.5414***	15.6427***
	(5.3441)	(6.2941)
Ind	13.9607***	23.8728***
	(3.6303)	(4.5092)
Sep	6.3843***	8.3500***
	(6.6269)	(7.4044)
Opin	0.6042	1.5320*
	(0.8727)	(1.8240)
Big10	1.1883**	1.2435**
	(2.0452)	(2.2844)
Constant	−12.9673*	−32.2077***
	(−1.6909)	(−2.8573)
Firm FE	Yes	Yes
Year FE	Yes	Yes
Pseudo R^2	0.3455	0.3645
Chi2	995.92***	997.36***
N	10810	10810

positive effect of *Lend* on *DOI* is mitigated if firms have strong internal control, lending support to Hypothesis 2. Moreover, Column (2) shows a significantly negative coefficient on *ShortSell × Analyst,* suggesting that the positive effect of *ShortSell* on *DOI* is significantly weakened for firms being followed by more analysts who serve as external monitors. Therefore, the analysis on analyst coverage lends support to Hypothesis 3.

Our cross-sectional analyses reveal that if firms have relatively strong governance in place, the likelihood of firms purchasing D&O insurance is less sensitive to short-selling threats. To the extent that D&O insurance is costly to shareholders as material agency cost, strong governance can offset the cost. A clear implication for shareholders is that in the presence of high short-selling pressure, firms may avoid purchasing D&O insurance by imposing strong governance.

4.5. Robustness tests

Thus far, we have examined how firms react to the increased short selling exposure by purchasing the D&O insurance using the DiD research design. In this section, we examine whether the impact of the short selling exposure on firms' D&O insurance purchase decision holds if we test the effect of short selling using a continuous measurement of short selling interest. To this end, we estimate the Probit model regressing *DOI* on short selling ratio (*Lend*), and other control variables. *Lend* is calculated with the shares available to be lent for short selling, scaled by outstanding shares at the beginning of the year. We obtained the equity lending data from the Markit Securities Finance (i.e. previously named Data Explorers). As a leading provider of global security lending information, it directly collects equity and bond lending information from the securities lending desks of the leading institutional traders around the world (Massa, Zhang, and Zhang 2015).

Table 7 Panel A reports the regression estimation result. Column (1) shows the results without controlling for any control variables, while column (2) reveals the estimation results controlling for all controls. In column (3), we report the estimation results of model (3), where industry and year fixed effects are controlled, along with control variables. Meanwhile, model (3) estimation has the standard errors clustered at firm level. Across all models, we find consistently significant and positive coefficients on *Lend*, indicating that firms with great short-selling interests tend to purchase the D&O insurance (*DOI*). Using the finding in column (3), the effect of *Lend* is not only statistically significant (coefficient 8.7823, z statistic 4.9572, $p < 0.01$) but also economically significant, in that one standard deviation increases in *Lend* leads to a 1.32% ([8.7823 × 0.0132] / 0.0879) increase in the likelihood of purchasing D&O insurance.

The sensitivity tests reported in Panel A are based on a continuous measurement of short selling interest, which does not solve the problem of endogeneity caused by reverse causality. That is, D&O insurance purchase decisions may be driven by opportunistic behavior of managers, which may be observed by short sellers resulting in increased short selling interests. Given this concern, we employed the Arellano-Bond linear estimation, and the results are presented in Panel B of Table 7. The Arellano-Bond estimator is a GMM estimator used to estimate dynamic panel data models, considering the unobserved panel-level effects correlated with the lags of the dependent variable (Arellano and Bond 1991). Since the D&O insurance purchase decisions and short selling interest (*Lend*) may be sticky across years (i.e. may be correlated with measures for previous years), we employ this dynamic estimation and control for the effect of the prior year's lendable shares and D&O insurance purchase in the GMM model (i.e. *L.DOI* and *L.Lend*). As shown in Panel C of Table 6, both the coefficients on *Lend* and *L.DOI* are positive and significant, suggesting that although firms tend to purchase D&O insurance in the current year if they also acquired the insurance in the preceding year, the positive and significant effect of short-selling interest on the current year's purchase decision cannot be explained away. Thus, both robustness analyses show findings with consistent implications with the DiD estimation results.

4.6. Test to alleviate the concern for reverse causality – is there an 'eyeball effect' of D&O insurance?

D&O insured firms account for a small percentage of listed firms. Therefore, the firms with D&O insurance may have attracted much attention in capital markets and remain under the scrutiny of the public – the so-called 'eyeball effect' (Yuan, Sun, and Cao 2016). If this were the case, *DOL* could attract short selling coverage – an issue of reverse causality. Hence, we further test whether the positive effect of short selling exposure may merely reflect the reverse causality. First, we measured the 'eyeball effect' using media coverage, because media coverage substantially affects a firm's information environment. We measure media coverage as the natural logarithm of the news reports about a given firm over a 1-year period. The data is retrieved from China Research Database Services (CNRDS). We then perform regression analyses on the media coverage on *DOI* and a set of control variables. A significantly positive coefficient on *DOI* would suggest an 'eyeball effect', while an insignificant coefficient on *DOI* would indicate that *DOI* is not the driving force of public attention and investors' interest.

Alternatively, following the approach used by Yuan, Sun, and Cao (2016), we use the number of analysts who followed the insured firms as a proxy for market attention, and we examine the effect of D&O insurance on the degree of market attention. This regression also controls for a set of variables following Bhushan (1989) and Yu

Table 7. Robustness tests.

Panel A: Regression using the short selling ratio as the independent variable

	DOI		
	(1)	(2)	(3)
Intercept	−2.3592∗∗∗	−13.3009∗∗∗	−14.1730∗∗∗
	(−68.7652)	(−15.5126)	(−14.3878)
Lend	10.5299∗∗∗	8.2176∗∗∗	8.7823∗∗∗
	(6.4341)	(4.7569)	(4.9572)
Size		0.3624∗∗∗	0.3923∗∗∗
		(12.4988)	(12.1103)
Lev		0.4865∗	0.8992∗∗∗
		(1.7626)	(2.9629)
TQ		0.0561	0.1072∗∗
		(1.1874)	(2.1131)
ROA		−1.6077∗	−1.9142∗
		(−1.7038)	(−1.9261)
Age		0.6744∗∗∗	0.7775∗∗∗
		(8.0905)	(8.0064)
Risk		4.7384∗∗∗	6.3236∗∗∗
		(3.0173)	(3.9425)
Cash		−0.7736∗∗∗	−0.3675
		(−1.9758)	(−0.8860)
Qratio		0.0900∗	0.1078∗∗
		(1.7427)	(2.0662)
SOE		0.4651∗∗∗	0.3913∗∗∗
		(4.6755)	(3.7538)
Share		−0.6930∗∗∗	−1.0063∗∗∗
		(−2.7677)	(−3.8228)
Board		0.2443	0.1113
		(1.2399)	(0.5452)
Ind		0.1480	0.3646
		(0.2289)	(0.5420)
Sep		0.1893∗∗	0.1687∗∗
		(2.4013)	(2.0692)
Opin		0.0646	0.1765
		(0.2839)	(0.7548)
Big10		0.3745∗∗∗	0.3888∗∗∗
		(4.7069)	(4.7558)
Industry FE	No	No	Yes
Year FE	No	No	Yes
Pseudo R^2	0.0061	0.1014	0.1243
Chi2	39.18∗∗∗	652.17∗∗∗	799.90∗∗∗
N	10810	10810	10810

Panel B: Arellano-Bond Generalized Method of Moment (GMM) estimation

	DOI
	(1)
Intercept	0.0700
	(0.8272)
L.DOI	0.5053∗∗∗
	(17.1520)
Lend	0.4817∗∗∗
	(4.4155)
L.Lend	0.2172∗
	(1.7839)
Size	0.0024
	(0.7070)
Lev	0.0071
	(0.4409)
TQ	0.0009
	(0.5047)

(*continued*).

Table 7. Continued.

Panel B: Arellano-Bond Generalized Method of Moment (GMM) estimation	
ROA	0.0565
	(1.6341)
Age	−0.0109
	(−0.9901)
Risk	0.0058
	(0.2730)
Cash	−0.0267
	(−1.5117)
Qratio	0.0000
	(0.0484)
SOE	0.0119
	(1.0016)
Share	0.0148
	(0.5752)
Board	0.0169
	(1.1742)
Ind	−0.0232
	(−0.6365)
Sep	0.0127**
	(2.0913)
Opin	−0.0046
	(−0.5942)
Big10	−0.0044
	(−1.0792)
Industry FE	Yes
Year FE	Yes
Wald Chi^2	794.25***
N	8183

(2008). For both regression estimations, we also control for year and industry fixed effects. The regression analyses results, as presented in Table 8, show that the coefficients on *DOI* in columns (1) and (2) are insignificant, indicating that firms' purchase of D&O insurance is not significantly associated with either media coverage or analyst coverage, suggesting that the D&O insurance does not garner more attention from financial news media or financial analysts in the capital market. Hence, we conclude that the positive relationship between D&O insurance and short-selling interest is not driven by the 'eyeball effect'.

5. Conclusion

As the first study to examine whether short-selling pressure shapes firms' insurance-purchasing decisions, the paper intends to enrich our understanding of how secondary stock market mechanisms interplay with managerial decision-making. Facing heightened litigation risk potentially triggered by short-selling activities, firms may be incentivized to purchase D&O insurance. We test this proposition using a logistic model, a battery of endogeneity tests, and DiD analysis. The findings consistently pinpoint a positive effect of short selling pressure on the likelihood of purchasing D&O insurance. Meanwhile, our path analysis suggests that the positive effect of short-selling pressure on the insurance purchase decision occurs via its effect on firms' litigation risk. Our cross-sectional analyses demonstrate that both strong internal control and analyst monitoring can mitigate firms' concern about short-selling pressure lowering their possibility of purchasing D&O insurance.

Collectively, in the context of short selling, this study extends the emerging literature on the influence of market makers on managerial D&O insurance purchase decisions. Our data add to the body of knowledge on the determinants of D&O insurance purchasing. Meanwhile, given the substantial premium paid for D&O insurance, the findings of a countervailing effect of strong internal control and external monitoring of financial analysts on firms' insurance purchase highlight the importance of strong governance in overcoming agency costs and protecting shareholders' wealth.

Table 8. Additional analysis: Does 'eyeball effect' explain the effect of short selling on D&O insurance?.

	Media (1)		Analyst (2)
Intercept	−8.6726***	Intercept	−91.0485***
	(−12.8100)		(−21.1996)
DOI	−0.0287	DOI	0.3412
	(−0.4309)		(0.5933)
MKV	0.2825***	MKV	4.2821***
	(9.3207)		(21.5578)
ROA	1.6062***	ROA	50.5905***
	(4.5591)		(17.6315)
BP	−0.0692	Growth	0.1725
	(−0.9078)		(0.7924)
LEV	0.4449***	Fin	−3.1819***
	(3.8290)		(−5.1274)
CSI_index	0.3150***	InsHold	0.3340***
	(4.3798)		(8.9578)
Risk	0.4840***	Ocfv	−1.7202
	(2.6956)		(−0.6577)
Ret	0.0634**		–
	(2.3236)		
AdExp	1.3700***		
	(5.1585)		–
Board	0.0622		
	(0.6658)		–
Ind	0.5461		
	(1.5512)		
SOE	−0.2125***		
	(−5.5224)		–
MktPE	0.1431***		
	(40.0415)		–
Industry	Yes	Industry	Yes
Year	Yes	Year	Yes
Firm cluster	Yes	Firm cluster	Yes
R^2	0.4595	R^2	0.5319
F value	191.72***	F value	51.65***
N	10,810	N	9,973

Note: We select the following control variables for the media coverage model. Book-to-market ratio (BP); *MKV*, firm size, is the natural logarithm of total market value of a firm. *CSI_index*, stock index to replicate the performance of top 300 stocks traded on the Shanghai Stock Exchange and the Shenzhen Stock Exchange. It is regarded as the Chinese counterpart of the S&P 500 index. Market price-to earnings ratio of all firms (*MktPE)*, a measure of market-wide investor sentiment. Boardsize, the log of number of board directors; *BoardIndep, board independence, the percentage of independent board members.* Growth (the increase in the percentage of sales), Fin (total funds raised from equity and debt divided by total assets in year t), Following Bhushan (1989) and Yu (2008), the analyst coverage model is defined with a separate set of control variables. InsHold (the percentage of shareholdings held by institutional investors); Ocfv (the standard deviation of yearly operating cash flows in prior three years). Other variables are as defined in the main variable definition.

Notes

1. Starting from 2002 when first batch of 28 firms started purchasing D&O insurance, the number of firms buying the insurance has reached 307 in 2019, an increase of 13 times.
2. It is a debatable issue whether the premium paid by firms for their directors and officers should be disclosed publicly. Donelson, Hopkins, and Yust (2018) examines how the regulation requiring firms to disclose D&O insurance information about the insurance premiums affects the litigation risks. They find that required disclosure of premium – a New York's mandatory disclosure policy, could trigger nonmeritorious litigations. Hence, the evidence provided by this study is suggestive of adverse effect of the disclosure regulations about D&O insurance.
3. Please refer to Jia, Mao, and Yuan (2019) for a list of names of listed Chinese firms whose directors and managers have been sued.
4. There are rare occasions when shares became shortable in one year but later were removed from the shortable list by the CSRC. Our sample has excluded firms of this kind.
5. Later for a sensitivity analysis, we exclude observations of 32 firms whose shares became shortable in 2010. Our results remain no change qualitatively.
6. We also check the results with an Ordinary Least Square (OLS) regression estimation following a few studies (e.g., Kim and Valentine 2021; Wu and Ye 2020) to alleviate the concern that Logit or Probit model may not adequately account for these fixed effects on the discrete dependent variable (Bertrand and Mullainathan 2003). Our OLS estimations demonstrate largely

consistent results with the Probit model analysis. Hence, our following estimations throughout the paper are all based on the Probit model.

7. The CSRC selects firms for short selling transactions, which is uncontrolled by firms. Therefore, our main DiD analysis is conducted on treatment and control sample observations that have not been matched. However, there might be inherent differences in firm characteristics between firms selected as shortable stocks (the treatment sample) and their control sample firms. If this is the case, the observed effect of the deregulation of short selling on disclosure could be attributed to these differences, which would introduce self-selection bias. To alleviate this concern, we use propensity score matching (PSM), following the PSM approach suggested by Austin (2011), to match the treatment and control sample observations based on a set of variables as shown in Panel C of Table 4, Section I. The matching covariates show no significant difference in those firm characteristics post matching. Hence, we use the matched sample to conduct the DiD test again. The results (untabulated) are largely consistent with the findings of the baseline regression.

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Appendix: Variable definition

Variable	Definition	Computation
DOI	D&O insurance	A dummy variable, taking value of 1 if a firm has an existing D&O insurance in place, and 0 otherwise.
ShortSell	Short selling exposure due to the deregulation	A dummy variable measuring a firm-year's exposure to short selling threats due to the short selling deregulation. A value of 1 is assigned to firms with shortable shares after the firms' shares became shortable, and 0 is assigned to their early years when shares were not shortable. In contrast, 0 is assigned to firm-year observations for firms with shares that have never become shortable over our sample period
Size	Firm size	natural logarithm of total assets;
Lev	Leverage	The ratio of total liabilities to total assets;
TQ	Tobin q	Market value of equity divided by total book value of equity;
ROA	Firm performance	The ratio of earnings before interest and taxes to total assets;
Age	Firm age	The natural logarithm of the number of years since a firm's incorporation;
Risk	Stock return volatility	Standard deviation of daily stock returns in a year;
Cash	Cash reserve	Cash and cash equivalents to total assets
Qratio	Short-term Financial Stability	Quick ratio, measured as the different current asset excluding inventories divided by current liabilities;
SOE	Controlling ownership	Dummy variable, taking value of 1 for state-owned enterprises (SOE), and 0 otherwise.
Share	Top shareholding	The proportion of shares held by the largest shareholder;
Board	Number of directors	The natural logarithm of the number of directors on board;
Ind	Independent directors	The proportion of independent directors to total directors;
Sep	control-ownership divergence	Dummy variable, taking value of 1 if voting rights differ from cash flow rights, and 0 otherwise.
Opin	Audit opinion	Dummy variable, taking value of 1 if the auditor issues unqualified opinion, and 0 otherwise.
Big10	Audit quality	Dummy variable that equals one if the firm's auditor is among the big-ten accounting firms
Lit_Risk	Litigation risk	Dummy variable, taking value of 1 if there is at least one lawsuit or administrative sanction against the firm in a year, and 0 otherwise. The data is retrieved from CSMAR.
IC	Internal control	The greater the score, the stronger a firm's internal control.
Analyst	Analyst coverage	The natural logarithm of the number of analysts following the firm.
Lend	Short selling interests	Lendable ratio, calculated with the shares available to be lent for short selling scaled by outstanding shares at the beginning of the year.
Media	Media coverage	The natural logarithm of the number of news reports about the firms in the year. Data are collected from China Research Database Services (CNRDS).