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Directors' and officers' liability insurance and stock price crash risk

Rongli Yuan [a], Jian Sun [b], Feng Cao [c,*]

[a] School of Business, Renmin University of China, China
[b] School of Accountancy, Central University of Finance and Economics, China
[c] Business School, Hunan University, No. 109 Shijiachong Road, Yuelu District, Changsha, Hunan 410006, China

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ABSTRACT

We investigate the impact of directors' and officers' insurance (D&O insurance) on stock price crash risk. We find that D&O insurance in China is negatively associated with stock price crash risk. This association is robust to a series of robustness checks including the use of alternative sample, Heckman two-step sample selection model, propensity score matching procedure, fixed effects model, the inclusion of some possibly omitted variables, and bootstrap method. Further analyses show that the impact of D&O insurance on crash risk is more pronounced in firms with lower board independence, non-Big 4 auditors, lower institutional shareholdings, and weaker investor protection; and the negative relationship between D&O insurance and crash risk is not driven by the eyeball effect. Moreover, we find that D&O insurance purchase is associated with less financial restatements and more disclosure of corporate social responsibility reports. Our findings provide support to the notion that D&O insurance appears to improve corporate governance.

1. Introduction

Directors' and officers' liability insurance (hereafter referred to as "D&O insurance") is a liability cover which is purchased by a company to cover all directors and managers for legal liability arising from their professional activities on behalf of the company. Its use is common for listed firms in common-law jurisdictions, such as Canada, the US, and the UK (Zou et al., 2008). For example, 97% of US firms carry D&O insurance coverage, the proportion of Canadian firms covered by this insurance is 86%. Even in Hong Kong the percentage of D&O insurance coverage is between 60% and 70%.[1]

Despite the prevalence of D&O insurance in developed capital markets, it is not without controversy. Two opposing arguments exist in the literature regarding the relationship between D&O insurance and corporate governance. One view is that there is a positive effect of D&O insurance on corporate governance. As an insurance to protect directors and officers against claims alleging breach of their duties (Lin et al., 2011), D&O insurance increases the incentive of directors and officers to act in the best interest of stakeholders, which plays a role in reducing agency cost, enhancing investor protection, and improving corporate governance (e.g., Core, 2000; Holderness, 1990). The other view is that there is a negative effect of D&O insurance on corporate governance.

* Corresponding author.
E-mail address: caofeng@hnu.edu.cn (F. Cao).

[1] Please refer to http://finance.eastmoney.com/news/1622,20141128451283861.html.

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Protecting directors and officers from nuisance suits, D&O insurance could induce unintended moral hazard and reduce the incentive of managers to act in the best interest of stakeholders (e.g., Chung and Wynn, 2008; Lin et al., 2013).

Based on developed capital markets, prior studies have provided empirical evidence on the negative impact of D&O insurance on corporate governance. In Canada, a higher level of D&O insurance coverage is associated with less conservative earnings (Chung and Wynn, 2008), lower announcement-period abnormal stock returns of acquirers (Lin et al., 2011), higher cost of equity (Chen et al., forthcoming), higher loan spreads, greater risk taking, higher probabilities of financial restatements (Lin et al., 2013), and poorer first year post-IPO stock performance (Boyer and Stern, 2014). In the US, firms with protected directors by D&O insurance are more likely to accept a lower bid premium (Aguir et al., 2013). In the UK, D&O insurance is associated with higher audit fees (O'Sullivan, 2009).

Compared with the developed capital markets, China provides a different setting to examine the effect of D&O insurance on corporate governance. The Chinese corporate sector is characterized by a highly concentrated ownership structure that is often dominated by a state-owned controlling shareholder (represented by government agencies) (Chen et al., 2011; Wei et al., 2005). Given that government agencies have effective control over company decisions, corporate governance is weak and the conflicts of interest between controlling and minority shareholders are severe (Young et al., 2009). Under China's Company Law, a corporation is required to have both a board of directors and a board of supervisors, which comprise the most important monitoring mechanisms. However, boards of supervisors in China are largely ineffective (Xiao et al., 2004; Wu et al., forthcoming), which raises the expectations of the role of independent directors in corporate governance. The Chinese securities regulatory commission (CSRC) adopted an independent director system in August 2001, hoping that independent directors can monitor controlling shareholders on behalf of minority shareholders. However, the evidence on the monitoring role of independent directors is mixed (e.g., Tang et al., 2013). Also, institutional investors only have limited power to influence firms since they own a small proportion of their shares (Jiang and Kim, 2015). Meanwhile, external control mechanisms, including external auditing, investor protection, law and law enforcement, are considered ineffective (Li et al., 2012). China is a civil-law socialist country where legal protection of private investors is limited (Chen et al., 2009; Zou et al., 2008). Private securities litigation (PSL) was not allowed until the promulgation of a specific PSL rule by the Supreme People's Court in 2002, but the enforcement of this rule is often clouded by the dilemma of protecting listed SOEs and defrauded private investors, and by local government protection of local interest (Zou et al., 2008).

Given weak internal and external governance, China's D&O insurers shall have the incentive to play their monitoring role in the corporate governance of the insured companies, in order to minimize their payout obligations. A question arises whether the purchase of D&O insurance has a positive effect on the corporate governance of insured companies under Chinese context, which is different from what the above literatures have concluded based on the developed capital markets, including Canada, the US, and the UK.

Due largely to the difficulty in obtaining D&O insurance data at the firm level in China, there is little evidence about how the purchase of this insurance affects corporate governance. Moreover, stock price crash risk is an important economic consequence of corporate governance. Prior studies have explored the determinants affecting stock price crash risk, including mandatory adoption of IFRS (DeFond et al., 2015), religion (Callen and Fang, 2015), tax avoidance (Kim et al., 2011a), equity incentives (Kim et al., 2011b), financial analysts (Xu et al., 2013), institutional investors (An and Zhang, 2013; Callen and Fang, 2013), accounting conservatism (Kim and Zhang, forthcoming), and management excess perks (Xu et al., 2014). However, no prior studies have systematically examined the impact of D&O insurance on crash risk.

We fill this void by examining the effect of D&O insurance on crash risk using a manually collected data on D&O insurance from China over the period 2002–2012. We find that the purchase of D&O insurance is negatively associated with stock price crash risk. This association is robust to a series of robustness checks, including adopting alternative sample, Heckman two-step sample selection model, propensity score matching (PSM) procedure, fixed effects model, the inclusion of some possibly omitted variables, and bootstrap method. Further analyses show that the impact of D&O insurance on crash risk is more pronounced in firms with lower board independence, non-Big 4 auditors, lower institutional shareholdings, and weaker investor protection and the negative relationship between D&O insurance and crash risk is not driven by the eyeball effect. Moreover, we find that D&O insurance purchase is associated with less financial restatements and more disclosure of "corporate social responsibility (hereafter referred to as "CSR") reports.

This study contributes to the extant literature in four ways. First, to the best of our knowledge, this study is the first to examine how D&O insurance impacts stock price crash risk. Our findings provide support to the notion that D&O insurance appears to reduce agency costs, enhance investor protection, and improve corporate governance. In this regard, we believe that this study adds an interesting and important piece to the D&O insurance and corporate finance literature.

Second, this study also contributes to the understanding of the effectiveness of D&O insurance as part of the corporate governance mechanisms. The existing literature is almost exclusively based on developed economies and has generated nearly consistent findings of negative impacts of D&O insurance on corporate finance (e.g., Chen et al., forthcoming; Lin et al., 2011). However, research has not been undertaken in major emerging economies such as China. Based on the manually collected data, we find a positive impact of D&O insurance on corporate governance in China's context, which is characterized with weak internal and external governance.

Third, our study broadly complements corporate governance literature by exploring the economic mechanisms through which D&O insurance could affect stock price crash risk. We find that D&O insurance purchase is associated with less financial restatements and more disclosure of CSR reports. The findings also contribute to the literature on the factors that impact financial restatements and CSR, respectively.

Fourth, our study also enriches the literature on the economic effects of D&O insurance. Prior studies have examined the impacts of D&O insurance on cost of equity (Chen et al., forthcoming), cost of debt (Lin et al., 2013), investment efficiency (Li and Liao, 2014), appointment of accounting firms (Chi and Weng, 2014), audit fees (Chung and Wynn, 2014; Chung et al., 2015), tax avoidance (Zeng, 2014), merger and acquisition (Lin et al., 2011), and diversification (Chi et al., 2013). Our study examines the impact of D&O insurance on stock price crash risk, thus enriching the literature by exploring a new economic consequence of D&O insurance.

The remainder of this study is organized as follows. We develop our hypothesis in Section 2. Section 3 describes the research design, including sample selection, model specification, and variable measurement. The empirical results are discussed in Section 4. Section 5 provides robustness checks and Section 6 performs further analyses, including the moderating effects of the monitoring mechanisms and an alternative explanation of the eyeball effect. Section 7 explores the economic mechanisms of D&O insurance on stock price crash risk. Section 8 concludes the paper.

2. Hypotheses development

Prior studies argue that corporate managers tend to withhold bad news due to formal compensation contracts and career concerns (Graham et al., 2005; Kothari et al., 2009; LaFond and Watts, 2008; Verrecchia, 2001), managerial opportunism (Kim et al., 2011a), and option portfolio value (Kim et al., 2011b). If managers withhold and accumulate bad news for an extended period, negative information is likely to be stockpiled within a firm. However, there is an upper limit to the amount of bad news that firms can absorb or accumulate. Once the amount of accumulated bad news reaches a certain threshold, it becomes too costly or impossible to continue to withhold it. When the accumulation of bad news reaches a tipping point, it will likely all be released at once, leading to large, negative stock returns on the individual stocks concerned, that is, stock price crashes (Hutton et al., 2009; Jin and Myers, 2006).

Following this idea, subsequent researchers have examined the determinants of stock price crash risk, including mandatory adoption of *IFRS* (DeFond et al., 2015), religion (Callen and Fang, 2015), tax avoidance (Kim et al., 2011a), equity incentives (Kim et al., 2011b), financial analysts (Xu et al., 2013), institutional investors (An and Zhang, 2013; Callen and Fang, 2013), accounting conservatism (Kim and Zhang, forthcoming), and management excess perks (Xu et al., 2014). In summary, one of the important determinants of stock price crash risk is managerial disclosure preferences motivated by the self-benefit.

Theoretically, there are two different views on the effect of D&O insurance on stock price crash risk.

One view is that listed firms introduce the monitoring provided by D&O insurer in underwriting through scrutiny of a firm's corporate governance after purchasing D&O insurance (Core, 2000; Holderness, 1990). This monitoring will constrain management opportunism, mitigate agency costs, control corporate information disclosure, and therefore, restraining stock price crash risk. Core (2000) argues that insurers have the capacity of exactly assess risks of insured firms, and control the behavior of the management through pricing the insurance and drawing up relevant clauses in contracts. To prevent and manage shareholder litigation losses, D&O insurers have a conservative assessment of the liability risk of each individual corporation before the sale of the insurance. To minimize the losses, they shall play a monitoring role of corporate governance of insured firms after the sale. Meanwhile, it is a norm that poorly governed firms are charged more for D&O insurance than better governed firms, therefore, the risk assessment and pricing practice provides an incentive for insured firms to minimize the risk of potential shareholder litigation. Hence, it is possible that corporate management communicates with D&O insurers on some bad news that might lead to shareholder litigation.

As an independent party, D&O insurers are concerned with the corporate governance of the insured companies and give an independent assessment, which adds the governance information to the market, and consequently forming an effective monitoring mechanism. Early studies, including Mayers and Smith (1982), have already paid much attention to the active impact of insurers on corporate governance of insured firms. Bhagat et al. (1987) argue that D&O insurance can control the conflicts of interests between shareholders and managers. Donley and Kent (2008) conclude that D&O liability insurance has become an integral part of corporate governance in Canada. Some prior studies have provided empirical support for this argument. For example, O'Sullivan (1997) finds that D&O insurance reduces agency costs and improves corporate governance, and Hoyt and Khang (2000)'s finding indicates that insurers reduce the conflicts of interests between shareholders and managers and mitigate agency problems.

The other view is that D&O insurance could induce unintended moral hazard and reduce the incentive of managers to act in the best interest of stakeholders, because it insulates directors and officers from the threat of litigation and personal financial liability resulting from their decisions on behalf of the corporation (Chung and Wynn, 2008; Lin et al., 2011, 2013). Therefore, once a firm purchases D&O insurance, managerial opportunism could be more pronounced, and managers are more likely to withhold negative information, which increases stock price crash risk. The current literature suggests that directors and officers protected by D&O insurance are more likely to undertake opportunistic behavior (Boyer, 2014; Wynn, 2008) and less likely to appoint Big 4 accounting firms (Chi and Weng, 2014). Furthermore, D&O insurance purchase increases loan spreads (Lin et al., 2013), cost of equity capital (Chen et al., forthcoming), audit fees (Chung and Wynn, 2014), and financial tax management (Zeng, 2014), while it lowers earnings conservatism (Chung and Wynn, 2008) and investment efficiency (Li and Liao, 2014).

Therefore, we propose two competing hypotheses for the effect of D&O insurance on stock price crash risk.

H1a. (the monitoring effect hypothesis): The purchase of D&O insurance decreases future stock price crash risk, other things being equal.

H1b. (the connivance effect hypothesis): The purchase of D&O insurance increases future stock price crash risk, other things being equal.

3. Research design

3.1. Construction of sample

Our sample initially comprised all firms listed on the SHSE and SZSE from 2002 to 2012. We choose 2002 as the beginning year of our sample period because the first D&O insurance appeared in that year.[2] The data on D&O insurance are manually collected from annual reports and disclosed minutes of boards' and shareholders' meetings, as the China's Securities and Regulatory Commission (CSRC) requires that any purchase of D&O insurance should be proposed by the board of directors and approved at shareholders' meetings. We exclude financial firms (e.g., banks, insurance companies, and investment trusts) as they account and report under rules, and tend to have a capital structure, different from other companies. According to Xu et al. (2014), we drop the firms with fewer than 30 trading weeks of stock return data in a fiscal year. Finally, we get a usable sample of 457 observations, representing 105 firms with D&O insurance coverage (i.e., insured firms).

Following Zou et al. (2008), we matched each observation in the insured firm sample with one uninsured observation by industry and year first, and then by firm size. This process results in a final sample of 914 observations. Following Armstrong et al. (2010) and Pana et al. (2015), we also use an alternative control sample matched with the propensity to purchase D&O insurance as a robustness check. The financial data used in this study are obtained from China Stock Market Accounting Research (CSMAR) system.

3.2. Models

The hypotheses to be tested are that stock price crash risk is a function of D&O insurance and other control variables. The basic empirical model employed is:

$$\mathrm{NCSKEW}_{t+1}(\mathrm{DUVOL}_{t+1}) = \beta_0 + \beta_1 \mathrm{D\&O}_t + \sum_{q=2}^{m} \beta_q (\mathrm{qth\ ControlVariable}_t) + \varepsilon_t \quad (1)$$

where β_i represents regression coefficients; ε is an error term; and *ControlVariable* contains $NCSKEW_t$, $Oturnover_t$, $Sigma_t$, Ret_t, $Size_t$, BM_t, Lev_t, ROA_t, $AbsACC_t$, year dummies, and industry dummies. $NCSKEW_{t+1}$ and $DUVOL_{t+1}$ measure stock price crash risk, whereas *D&O* represents D&O insurance coverage. A negative (positive) β_1 suggests that D&O insurance tends to decrease (increase) stock price crash risk. All the main variables are defined in Appendix A.

3.3. Variables

3.3.1. Dependent variable: stock price crash risk

Following An and Zhang (2013), Callen and Fang (2013), Chen et al. (2001), Hutton et al. (2009), Jin and Myers (2006), and Kim et al. (2011a,b), we employ two measures of firm-specific crash risk. Both measures are based on firm-specific weekly returns (denoted by *W*) estimated as the residuals from the market model. Using firm-specific returns to ensure that our crash risk measures reflect firm-specific factors rather than broad market movements. Specifically, we estimate the following expanded market model regression:

$$r_{i,t} = \alpha_i + \beta_1 r_{M,t-2} + \beta_2 r_{M,t-1} + \beta_3 r_{M,t} + \beta_4 r_{M,t+1} + \beta_5 r_{M,t+2} + \epsilon_{i,t} \quad (2)$$

where $r_{i,t}$ is the return on stock i in week t, and $r_{M,t}$ is the return on the value-weighted market index in week t.[3] The lead and lag terms for the market index return are included to allow for nonsynchronous trading (Dimson, 1979). The firm-specific weekly return for firm i in week t ($W_{i,t}$) is calculated as the natural logarithm of one plus the residual return from Eq. (2), that is $W_{i,t} = ln(1 + \varepsilon_{i,t})$.

Our first measure of crash risk is the negative conditional skewness of firm-specific weekly returns over the fiscal year (*NCSKEW*). *NCSKEW* is calculated by taking the negative of the third moment of firm-specific weekly returns for each year and normalizing it by the standard deviation of firm-specific weekly returns raised to the third power. Specifically, we calculate the *NCSKEW* for each firm i in year t as

$$\mathrm{NCSKEW}_{i,t} = -\left[n(n-1)^{3/2}\sum W_{i,t}^3\right] \Big/ \left[(n-1)(n-2)\left(\sum W_{i,t}^2\right)^{3/2}\right] \quad (3)$$

[2] In January 2002, Pingan Insurer, together with the Chubb Corporation of the US, sold the D&O insurance to Vanke Corporation. It is the first sale of D&O insurance in China.

[3] We also run the regression using the equal-weighted market return and total market return and find similar results.

where n is the number of trading weeks on stock i in year t. A higher value for *NCSKEW* corresponds to a stock being more "crash prone" and vice versa.

The second measure of crash risk is the down-to-up volatility (*DUVOL*), which we calculate as

$$\mathrm{DUVOL}_{i,t} = \log\left\{\left[(n_u - 1)\sum_{\mathrm{Down}} W_{i,t}^2\right] / \left[(n_d - 1)\sum_{\mathrm{Up}} W_{i,t}^2\right]\right\} \tag{4}$$

where n_u and n_d are the number of up and down weeks, respectively. A higher value of *DUVOL* indicates greater crash risk.

3.3.2. Test variable: D&O insurance

Following prior studies (e.g., Zou et al., 2008), we adopt a dummy variable (*D&O*) to measure D&O insurance, which equals 1 if a firm purchases D&O insurance in year t, and 0 otherwise.

3.3.3. Control variables

We control for several factors that have been shown to affect future stock price crash risk in prior studies. The variable $NCSKEW_t$ is the negative skewness of firm-specific weekly returns in year t. Chen et al. (2001) find that firms with high return skewness in year t are likely to have high return skewness in year $t + 1$ as well. $Oturnover_t$ is the detrended average monthly stock turnover in year t, calculated as the average monthly share turnover in year t minus the average monthly share turnover in year $t - 1$. Chen et al. (2001) adopt this measure to measure differences of opinion among investors and find this detrended turnover variable to be positively related to future crash risk. As volatile stocks are positively associated with future stock price crashes (Chen et al., 2001), we add the variable $Sigma_t$, which is the standard deviation of firm-specific weekly returns over the fiscal year period t. The predictive power of past returns can be explained by a bubble buildup as indicated by high past returns, followed by a large price drop when prices fall back to fundamentals. We thus control for past returns (Ret_t), calculated as the arithmetic average of firm-specific weekly returns in year t. The authors also show that stocks with high past returns are more likely to crash. The variable $Size_t$ is defined as the natural logarithm of the book value of total assets in year t. Both Chen et al. (2001) and Hutton et al. (2009) report a positive relation between size and crash risk. As firms with low book-to-market ratios could have more stochastic bubbles and higher crash risk (Chen et al., 2001), we control for the book-to-market ratio (BM_t), which is measured as the book value of equity divided by the market value of equity in year t. In addition, we control for financial leverage (Lev_t), which equals the book value of total debt divided by the book value of total assets. The variable ROA_t is defined as net profit divided by the book value of total assets in year t. Hutton et al. (2009) show that financial leverage and operating performance are both negatively related to crash risk. As Hutton et al. (2009) find a positive association between earnings management and future crash risk, we control for abnormal accruals, a proxy for earnings management. We use the absolute value of abnormal accruals ($AbsACC_t$) in our regression analysis, calculated as the residuals from the modified Jones model (Dechow et al., 1995). Appendix A provides definitions of all variables used in our analysis and all continuous variables are winsorized at 1% at both tails.

4. Empirical analyses

4.1. Descriptive statistics

Table 1 provides descriptive statistics for the variables used in our analysis. The means of the crash risk measures, *NCSKEW* and *DUVOL*, are −0.215 and −0.251, respectively, which are similar to the estimates in Xu et al. (2014). The mean of detrended average monthly stock turnover (*Oturnover*) is −0.026. The mean of standard deviation of firm-specific weekly returns is 0.063. The

Table 1
Descriptive statistics. This table reports descriptive statistics on crash risk, D&O insurance, and control variables for the sample in 2002–2012. All variables are defined in Appendix A.

Variable	Obs.	Mean	Std. dev.	Minimum	Median	Maximum
$NCSKEW_{t+1}$	914	−0.215	0.793	−2.247	−0.197	1.807
$DUVOL_{t+1}$	914	−0.251	0.733	−2.020	−0.254	1.580
$D\&O_t$	914	0.500	0.500	0.000	0.500	1.000
$NCSKEW_t$	914	−0.235	0.800	−2.187	−0.230	1.823
$Oturnover_t$	914	−0.026	0.319	−1.084	−0.008	0.854
$Sigma_t$	914	0.063	0.025	0.024	0.057	0.134
Ret_t	914	0.000	0.013	−0.027	−0.002	0.034
$Size_t$	914	22.288	1.656	19.034	21.974	26.854
BM_t	914	0.292	0.156	−0.045	0.273	0.805
Lev_t	914	0.526	0.201	0.069	0.544	1.138
ROA_t	914	0.033	0.075	−0.370	0.034	0.202
$AbsACC_t$	914	0.081	0.091	0.001	0.048	0.423

firms in our sample have an average size of 22.288, an average book-to-market ratio of 0.292, an average leverage of 0.526, and an average return on assets of 0.033. The average absolute value of abnormal accruals is 0.081.

4.2. Correlation analysis

We calculated Pearson and Spearman correlation coefficients between variables.[4] The untabulated results suggest that $D\&O_t$ is significantly and negatively correlated with $NCSKEW_{t+1}$ and $DUVOL_{t+1}$, which is consistent with H1a. The results also show that all the correlations between the independent variables are relatively low.

To further test the existence of multicollinearity, we compute the variance inflation factor (VIF) for independent variables and the largest one is 6.78, well below the rule of thumb cutoff of 10.00 for multiple regression models (Kennedy, 1998). Thus we conclude that multicollinearity is unlikely to be a serious problem in our study.

4.3. Univariate analysis

Table 2 reports the results of univariate tests of the key variables used in this study. The mean of $NCSKEW_{t+1}$ ($DUVOL_{t+1}$) is −0.278 (−0.303) for the insured firms and −0.153 (−0.199) for the uninsured firms, and the differences are both statistically significant at the 5% level. This means that insured firms have lower stock price crash risk than uninsured firms.

Fig. 1 depicts the relationship between future crash risk and D&O insurance. As illustrated in panel A, the stock price crash risk of the insured firms is lower than that of the uninsured firms when *NCSKEW* is proxied for stock price crash risk. This result is still valid when *DUVOL* is adopted in panel B.

4.4. Multivariate results

Table 3 displays the results of four regression models used to test our hypotheses. These models are derived from two measures of stock price crash risk.

H1a is supported by the negative and significant coefficients of *D&O* in regressions using both *NCSKEW* and *DUVOL*. Specifically, the coefficients of the variable *D&O* in columns (2) and (4) are −0.137 and −0.113, both statistically significant at the 1% level, indicating that the purchase of D&O insurance reduces the likelihood of future stock price crash. This result is consistent with the notion that due to monitoring from D&O insurance companies, D&O insured firms are less likely to hoard bad news and exhibit a higher level of transparency, leading to lower future stock price crash risk.

The coefficients of the control variables are generally consistent with prior studies (e.g., Xu et al., 2014). Firms with higher returns, lower book-to-market ratios, lower leverage, and lower ROA are associated with higher future crash risk.

5. Robustness checks

In this section we perform several robustness checks to examine the sensitivity of our results, including adopting alternative sample, Heckman two-step sample selection model, PSM procedure, fixed effects model, the inclusion of some omitted variables, and bootstrap method.

5.1. Alternative sample

Following Zou et al. (2008), we use an alternative control sample consisting of the two closest-size matched firms in the same industry and year (1:2 matching) as a robustness check. In addition, we adopt two other control samples to estimate model (1), one is the matched sample consisting of three closest-size matched firms (1:3 matching) and the other is the one consisting of all the uninsured firms (full sample). All the results are reported in Table 4.

As shown in Table 4, the coefficients of *D&O* are significantly negative across all the six columns. This means that our results are not driven by the choice of sample.

5.2. Endogeneity

The hypothesis to be tested is that stock price crash risk is a function of D&O insurance and other control variables. However, the results will be difficult to interpret when there is a problem of endogeneity. For example, it might be possible that insurers tend to choose the firm with lower future stock price crash risk as their clients. We address the potential endogeneity issue in several ways, including adopting Heckman two-step sample selection model, PSM procedure, fixed effects model, and the inclusion of some possibly omitted variables.

[4] The results are available upon requests.

Table 2
Univariate analysis. This table reports the results of univariate analysis on the mean and median differences of the two crash risk measures *NCSKEW* and *DUVOL* between D&O insured firms and matched sample firms. *NCSKEW* and *DUVOL* are measured over year $t+1$ and defined in models (3) and (4). The *t*-values and *z*-values for differences in means (medians) are based on *t*-tests (Wilcoxon tests).

	Insured firms ($D\&O = 1$)			Matched sample firms ($D\&O = 0$)			Differences	
	Obs.	Mean	Median	Obs.	Mean	Median	T value	Z value
$NCSKEW_{t+1}$	457	−0.278	−0.263	457	−0.153	−0.128	2.385**	2.154**
$DUVOL_{t+1}$	457	−0.303	−0.307	457	−0.199	−0.219	2.134**	1.981**

** Denotes significance at the 5% level (two-tailed).

5.2.1. Heckman two-step sample selection model

A firm's decision to purchase D&O insurance may be non-random and this may cause a self-selection bias. We adopt the Heckman two-step sample selection model as an additional check. In the first step, we estimate a probit model with a binary D&O insurance dummy (*D&O*, which equals 1 if a firm purchases D&O insurance, 0 otherwise) as the dependent variable using the matched sample with 1:1 matching.

We add the following determinants of D&O insurance purchase: *Independence* (the proportion of independent directors on board), *ManHold* (the proportion of shares held by top executives), *CrossList* (a dummy variable that equals 1 when a firm is cross-listed, 0 otherwise), *Violation* (a dummy variable that equals 1 if a firm has a violation record, 0 otherwise), *Balance* (controlling shareholder's power, measured by the sum of shareholdings of the second to fifth largest shareholders divided by the shareholdings of the largest shareholder), *SOE* (a dummy variable that equals 1 when the ultimate controlling shareholder of a listed firm is the state, 0 otherwise), *Size* (firm size), *Lev* (financial leverage), *ROA* (return on assets), *BM* (the growth opportunity), and *IndAvg_D&O* (the mean incidence of D&O insurance purchase for firms in the same industry in the same year, excluding the firm concerned). Heckman's estimator requires exogenous variables that are correlated with a firm's propensity to purchase D&O insurance, but not with stock price crash risk. Note that *IndAvg_D&O* is likely to be an important factor for a listed firm when deciding whether to purchase D&O insurance, but less likely to be closely correlated with stock price crash risk. The variables are defined in Appendix A. The specification of the probit model is as follows.

$$D\&O_t = \alpha + \beta_1 \text{Indenpendence}_t + \beta_2 \text{ManHold}_t + \beta_3 \text{CrossList}_t + \beta_4 \text{Violation}_t + \beta_5 \text{Balance}_t + \beta_6 \text{SOE}_t + \beta_7 \text{Size}_t + \beta_8 \text{Lev}_t + \beta_9 \text{ROA}_t + \beta_{10} BM_t + \beta_{11} \text{IndAvg\_D\&O}_t + \text{YR} + \text{Ind} + \varepsilon_t \quad (5)$$

The inverse Mills ratio (*IMR*) is generated and then included in the second-step model to control for the potential sample selection bias. The specification of the second-step model is the same as model (1) described in Section 3.2. Table 5 reports the regression results of Heckman model. The results of the first-step regression show that *Independence*, *CrossList*, *Violation*, and *SOE* have significant and positive impacts on a firm's decision to purchase D&O insurance, whereas *ManHold* and *BM* have significantly negative impacts.

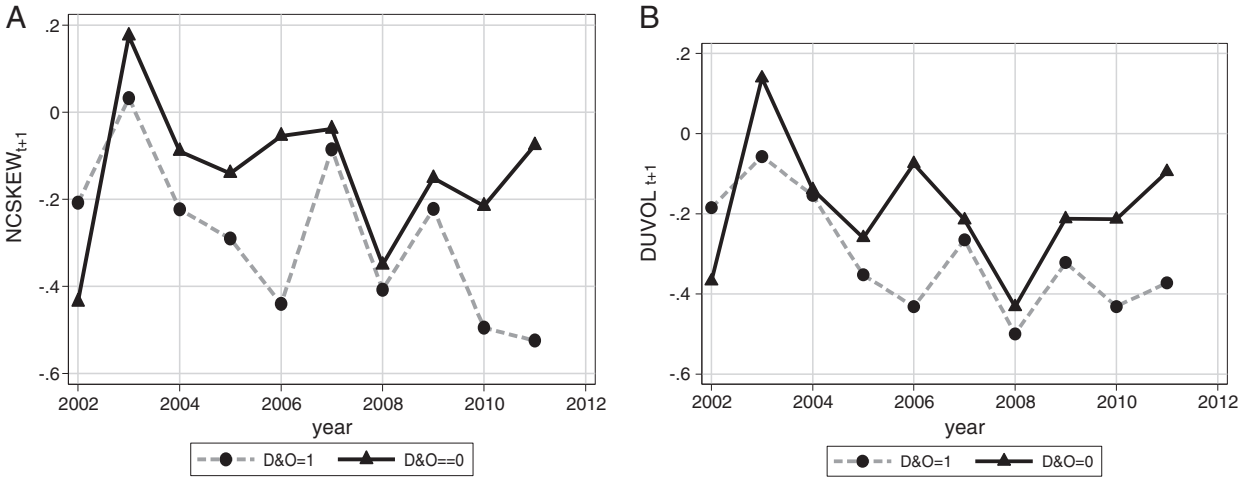

Fig. 1. The relationship between D&O insurance and stock price crash risk.

Table 3
D&O insurance and crash risk. This table presents the results from the ordinary least squares regression of the impact of D&O insurance on future stock price crash risk. The dependent variables *NCSKEW* and *DUVOL* are measured over year $t+1$ and defined in models (3) and (4). The test variable is *D&O*. Reported in parentheses are *t*-values based on robust standard errors clustered by both firm and year. All variables are defined in Appendix A.

	(1)	(2)	(3)	(4)
	$NCSKEW_{t+1}$	$NCSKEW_{t+1}$	$DUVOL_{t+1}$	$DUVOL_{t+1}$
$D\&O_t$	−0.129***	−0.137***	−0.107***	−0.113***
	(−3.02)	(−3.01)	(−3.04)	(−3.00)
$NCSKEW_t$		0.061		0.064
		(1.00)		(1.34)
$Oturnover_t$		0.083		0.103
		(0.87)		(1.15)
$Sigma_t$		0.845		−0.748
		(0.39)		(−0.45)
Ret_t		2.543		4.423
		(0.38)		(0.93)
$Size_t$		0.033*		0.019
		(1.90)		(1.47)
BM_t		−1.066***		−0.838**
		(−3.17)		(−2.45)
Lev_t		−0.570**		−0.466*
		(−2.18)		(−1.84)
ROA_t		−0.647**		−0.587*
		(−2.36)		(−1.76)
$AbsACC_t$		0.107		0.088
		(0.42)		(0.46)
Constant	0.063	−0.970**	0.023	−0.785***
	(0.01)	(−2.56)	(0.01)	(−2.72)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	914	914	914	914
Adjusted R^2	0.033	0.047	0.031	0.040

* Indicates significance at the 10% level (two-tailed).
** Indicates significance at the 5% level (two-tailed).
*** Indicates significance at the 1% level (two-tailed).

The results of the second-step regressions show that the coefficients of the variable *D&O* remain significantly negative when both *NCSKEW* and *DUVOL* are adopted. The coefficient of the inverse Mills ratio is significant and negative when *NCSKEW* is used to measure crash risk. This implies that the unobserved factors that motivate firms to purchase D&O insurance are negatively related to crash risk.

5.2.2. PSM procedure

We control for the potential endogeneity between the D&O insurance purchase decision and the stock price crash risk by comparing insured firms to a sample of control firms matched on the propensity to purchase D&O insurance (Armstrong et al., 2010; Pana et al., 2015). The primary benefit of using a control sample matched on propensity scores is that it allows us to compare the D&O insured firms to a set of firms that are the same on all observable dimensions, thus allowing us to more clearly attribute any observed effects to D&O insurance purchase itself, rather than to the firm characteristics associated with D&O insurance purchase (Bowen et al., 2010).

To identify the propensity-score matched control sample, we estimate a probit model using the full sample. The specification of the probit model is the same as model (5) described in Section 5.2.1. We then calculate a propensity score for each firm, which is the conditional probability that a firm purchase D&O insurance given all the observable data. For each D&O insured firm, we select one control firm with the closest propensity scores, and these firms constitute the propensity-score matched control sample. Finally we re-estimate model (1) using the insured and matched control sample. The results are reported in panel A of Table 6.

To ensure that the matching is satisfactory, we assess covariate balance by testing whether the means and medians of the covariates used in model (5) differ between the insured firms and matched controls firms and report the results in panel B of Table 6. As panel B shows, there are no significant differences in means and medians of any of the covariates, indicating that the propensity-score matched control sample resembles the D&O insured firms along virtually all dimensions.

In panel A of Table 6, the results of the probit regression show that the determinants of D&O insurance purchase are broadly similar to the main results of the first-step regression in Table 5. In the OLS regressions, the coefficients of $NCSKEW_{t+1}$ and $DUVOL_{t+1}$ are both significantly negative at the 1% level. This suggests a negative relationship between D&O insurance and stock price crash risk.

Table 4
The impact of D&O insurance on stock price crash risk using different matched sample. This table presents the results from the ordinary least squares regression of the impact of D&O insurance on future stock price crash risk. The dependent variables *NCSKEW* and *DUVOL* are measured over year $t+1$ and defined in models (3) and (4). The test variable is *D&O* insurance. Columns (1) and (2) contain the results for the regressions with the insured firms sample and control sample using 1:2 matching. Columns (3) and (4) contain the results for the regressions with the insured firms and control sample using 1:3 matching. Columns (5) and (6) contain the results for the regressions with the full sample. Reported in parentheses are *t*-values based on robust standard errors clustered by both firm and year. All variables are defined in Appendix A.

	1:2 matching		1:3 matching		Full sample	
	(1)	(2)	(3)	(4)	(5)	(6)
	$NCSKEW_{t+1}$	$DUVOL_{t+1}$	$NCSKEW_{t+1}$	$DUVOL_{t+1}$	$NCSKEW_{t+1}$	$DUVOL_{t+1}$
$D\&O_t$	−0.105***	−0.075***	−0.102***	−0.074***	−0.036*	−0.034**
	(−2.80)	(−2.61)	(−3.37)	(−3.67)	(−1.73)	(−2.10)
$NCSKEW_t$	0.039	0.044	0.060	0.053	0.049**	0.045**
	(0.90)	(1.49)	(1.35)	(1.43)	(2.16)	(2.46)
$OTurnover_t$	0.031	0.044	0.017	0.013	−0.035	−0.039
	(0.60)	(0.66)	(0.31)	(0.20)	(−0.77)	(−0.91)
$Sigma_t$	0.792	−0.810	1.227	−0.149	1.819*	0.053
	(0.47)	(−0.45)	(0.95)	(−0.11)	(1.87)	(0.05)
Ret_t	3.006	4.756	4.278	5.459*	3.824	4.980**
	(0.53)	(1.49)	(0.80)	(1.79)	(1.22)	(2.19)
$Size_t$	0.048***	0.030**	0.040**	0.022	0.032	0.021
	(2.77)	(2.18)	(2.57)	(1.61)	(1.30)	(1.26)
BM_t	−0.704***	−0.466**	−0.682***	−0.441**	−0.601***	−0.470***
	(−2.80)	(−2.04)	(−2.73)	(−2.27)	(−3.33)	(−3.37)
Lev_t	−0.411**	−0.271*	−0.275*	−0.127	−0.213**	−0.138*
	(−2.00)	(−1.68)	(−1.67)	(−1.03)	(−2.13)	(−1.76)
ROA_t	−0.951***	−0.689***	−1.063***	−0.680**	−0.641**	−0.393
	(−4.80)	(−2.95)	(−4.10)	(−2.57)	(−2.29)	(−1.63)
$AbsACC_t$	−0.067	−0.093	0.156	0.101	0.288*	0.218**
	(−0.35)	(−0.71)	(0.72)	(0.64)	(1.68)	(2.08)
Constant	−0.429*	−0.068	−0.442	−0.078	−1.064*	−0.755*
	(−1.66)	(−0.23)	(−1.62)	(−0.21)	(−1.71)	(−1.66)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	1368	1368	1824	1824	13645	13645
Adjusted R^2	0.043	0.032	0.056	0.043	0.040	0.043

* Indicates significance at the 10% level (two-tailed).
** Indicates significance at the 5% level (two-tailed).
*** Indicates significance at the 1% level (two-tailed).

5.2.3. Fixed effects model

To mitigate potential problems that may arise from omitting time-invariant firm-specific characteristics, we re-estimate the regression of model (1) using the fixed effects model and report the results in Table 7. As shown in Table 7, the estimated coefficients of the variable *D&O* in the four columns are significantly negative at the 1% level. This implies that our results are not driven by time-invariant firm-specific characteristics.

5.2.4. The inclusion of some omitted variables

To mitigate the endogeneity caused by omitted correlated variables, we add to model (1) a number of possibly omitted variables, including accounting conservatism, tax avoidance, internal control quality, and some other corporate governance factors that may potentially affect both D&O insurance and crash risk. Kim and Zhang (forthcoming) find that accounting conservatism is negatively related to crash risk as it restrains top executives' behavior from exaggerating firm performance and concealing bad news. We adopt *Cscore* used by Khan and Watts (2009) to proxy for accounting conservatism. Kim et al. (2011a) find corporate tax avoidance aggravates the crash risk. We take the variable *DDBT* used by Desai and Dharmapala (2006) to proxy for tax avoidance behavior. Moreover, following the prior studies (e.g., Xu et al., 2014), we control a number of corporate governance factors, including *LnBoardSize* (board size, measured by the natural logarithm of the number of board directors in a board), *Independence* (the proportion of independent directors on a board), *Duality* (a dummy variable that equals one if the CEO and board chairman are the same person and zero otherwise), *FstHold* (the percentage of shares held by the largest shareholder), *InsHold* (the percentage of shares owned by institutional investors), *Protect* (investor protection, measured as the natural logarithm of provincial investor protection index in year *t*), and *SOE* (a dummy variable that equals one if the ultimate controlling shareholder of a listed firm is the state in year t and zero otherwise). In addition, we control for the internal control quality (*lnIC*), which is the natural logarithm of one plus the China internal control quality index.[5] A similar measure is also used in Li (2015).

[5] The index is extracted from the DIB database that is available via http://www.ic-erm.com.

Table 5
The regression results of Heckman model. This table reports the regression results of Heckman model using the insured sample and control sample matched by one-to-one. The first step is a probit model with a binary D&O insurance dummy and the second step is the ordinary least square regression of the impact of D&O insurance on future stock price crash risk (see model (5)). The specification of the second-step model is the same as model (1) described in Section 3.2. The dependent variable *NCSKEW* and *DUVOL* in the second step are measured over year $t+1$ and defined in models (3) and (4). IMR_t denotes the inverse Mills ratio generated from the first step and included in the second step of this model. Reported in parentheses are *t*-values based on robust standard errors clustered by both firm and year. All variables are defined in Appendix A.

First-step regression		Second-step regressions		
$D\&O_t$			$NCSKEW_{t+1}$	$DUVOL_{t+1}$
$Independence_t$	2.577***	$D\&O_t$	−0.192***	−0.131***
	(2.59)		(−3.96)	(−3.58)
$ManHold_t$	−4.421***	$NCSKEW_t$	−0.000	0.014
	(−3.34)		(−0.00)	(0.23)
$CrossList_t$	0.373**	$OTurnover_t$	0.081	0.098
	(2.35)		(0.68)	(0.92)
$Violation_t$	0.333***	$Sigma_t$	2.180	0.457
	(3.16)		(0.86)	(0.21)
$Balance_t$	0.126	Ret_t	1.011	1.992
	(1.24)		(0.12)	(0.31)
SOE_t	0.380***	$Size_t$	0.001	−0.005
	(3.05)		(0.01)	(−0.39)
$Size_t$	0.049	BM_t	−0.626***	−0.523*
	(1.01)		(−2.66)	(−1.73)
Lev_t	−0.581	Lev_t	−0.269	−0.190
	(−1.36)		(−1.57)	(−1.03)
ROA_t	1.448*	ROA_t	−0.191	−0.049
	(1.68)		(−0.62)	(−0.15)
BM_t	−1.370***	$AbsACC_t$	0.097	0.065
	(−2.76)		(0.30)	(0.23)
$IndAvg\_D\&O_t$	2.515**	IMR_t	−0.256**	−0.120
	(1.99)		(−1.99)	(−0.92)
Constant	−2.762**	Constant	0.239	0.299
	(−2.16)		(0.66)	(0.61)
Year fixed effects	Yes	Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Industry fixed effects	Yes	Yes
Observations	766	Observations	766	766
Pseudo R^2	0.090	Adjusted R^2	0.051	0.030

* Indicates significance at the 10% level (two-tailed).
** Indicates significance at the 5% level (two-tailed).
*** Indicates significance at the 1% level (two-tailed).

We then re-estimate the regressions of model (1). The results are reported in Table 8. We find that the coefficients on *D&O* remain significantly negative across the six columns reported in the table. Thus, our finding of a negative relationship between D&O insurance and future stock price crash risk is robust to the inclusion of additional controls to mitigate the concern on omitted correlated variables.

5.3. Bootstrap method

Our sample consists of 914 observations, which may be relatively small to assure the normal distribution requirement for OLS regression. To resolve this problem, we use the bootstrap method to calculate the standard deviation, as this method does not need the normal distribution of data (Crespí-Cladera and Pascual-Fuster, 2014). Table 9 reports the regression results using a bootstrap method. We find the results are broadly same as our main findings.

6. Further analyses

6.1. The moderating effects of monitoring mechanisms

It is a norm that poorly governed firms are charged more for D&O insurance than better governed firms, therefore, the risk assessment and pricing practice provides an incentive for insured firms to minimize the risk of potential shareholder litigation. Hence, it is possible that corporate management communicate with D&O insurers on some bad news that might lead to shareholder litigation. On the other hand, in order to minimize their payout obligations, D&O insurance companies shall have the incentive to play their monitoring role in the corporate governance of the insured companies. As discussed above, the corporate governance of China's listed firms is weak, and it is essential for D&O insurers to monitor corporate management to protect their benefits.

Table 6
The regression results using PSM procedure. Panel A of this table reports the results from a probit model with a binary D&O insurance dummy using the full sample and the ordinary least square regression of the impact of D&O insurance on future stock price crash risk. The specification of the probit model is the same as the first-step of Heckman model described in Section 5.2.1 (also see Table 5). In the OLS regression, the dependent variables *NCSKEW* and *DUVOL* are measured over year $t+1$ and defined in models (3) and (4), and the independent variables are firm characteristics measures. Panel B reports the results of covariate balance checks on the mean and median difference in the covariates used in the probit model between the D&O insured firms and the matched control firms, when propensity score matching is adopted. Reported in parentheses are *t*-values based on robust standard errors clustered by both firm and year. All variables are defined in Appendix A.*

Panel A: The regression results using PSM procedure

Probit regression		OLS regressions		
$D\&O_t$			$NCSKEW_{t+1}$	$DUVOL_{t+1}$
$Independence_t$	0.283	$D\&O_t$	−0.169***	−0.141***
	(0.58)		(−3.51)	(−3.65)
$ManHold_t$	−2.394***	$NCSKEW_t$	0.034	0.063
	(−3.43)		(0.42)	(0.83)
$CrossList_t$	0.232***	$OTurnover_t$	0.112	0.129
	(3.23)		(1.09)	(0.97)
$Violation_t$	0.189***	$Sigma_t$	1.677	−0.144
	(3.74)		(0.49)	(−0.05)
$Balance_t$	0.101**	Ret_t	8.186	8.209
	(2.19)		(0.85)	(0.98)
SOE_t	0.150***	$Size_t$	−0.024	−0.023
	(2.61)		(−0.81)	(−0.98)
$Size_t$	0.263***	BM_t	−0.428	−0.328
	(9.95)		(−1.20)	(−0.94)
Lev_t	−0.476**	Lev_t	−0.050	−0.023
	(−2.45)		(−0.19)	(−0.09)
ROA_t	0.071	ROA_t	0.698	0.506
	(0.15)		(1.04)	(0.85)
BM_t	−0.991***	$AbsACC_t$	0.075	−0.045
	(−4.13)		(0.19)	(−0.12)
$IndAvg\_D\&O_t$	9.522***			
	(6.38)			
Constant	−7.787***	Constant	−0.236	−0.036
	(−13.60)		(−0.47)	(−0.10)
Year fixed effects	Yes	Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Industry fixed effects	Yes	Yes
Observations	11,625	Observations	826	826
Pseudo R^2	0.118	Adjusted R^2	0.092	0.079

Panel B: The results of covariate balance checks

	Insured firms ($D\&O=1$)			Matched control firms ($D\&O=0$)			Differences	
	Obs.	Mean	Median	Obs.	Mean	Median	*t* value	*z* value
$Independence_t$	412	0.358	0.333	412	0.357	0.333	−0.237	−0.955
$ManHold_t$	412	0.004	0.000	412	0.005	0.000	0.458	−0.522
$CrossList_t$	412	0.226	0.000	412	0.235	0.000	0.330	0.331
$Violation_t$	412	0.536	1.000	412	0.541	1.000	0.140	0.140
$Balance_t$	412	0.541	0.304	412	0.515	0.301	−0.681	0.445
SOE_t	412	0.767	1.000	412	0.774	1.000	0.248	0.248
$Size_t$	412	22.315	22.017	412	22.286	22.120	−0.286	0.160
Lev_t	412	0.530	0.551	412	0.520	0.534	−0.783	−0.808
ROA_t	412	0.039	0.034	412	0.040	0.036	0.284	0.314
BM_t	412	0.286	0.262	412	0.283	0.264	−0.303	−0.163
$IndAvg\_D\&O_t$	412	1.809	1.655	412	1.804	1.706	−0.054	0.314

** Indicates significance at the 5% level (two-tailed).
*** Indicates significance at the 1% level (two-tailed).

Therefore, we predict that the negative relationship between D&O insurance and crash risk is more pronounced in firms with weaker monitoring mechanisms. The monitoring mechanisms include board independence, Big 4 auditors, and institutional investors, and provincial investor protection.

6.1.1. Board independence

We divide the sample into two subsets: the higher board independence subset with the proportion of independent directors above the median of the same year and industry, and the lower board independence subset with the proportion below the median. We re-estimate model (1) with the two subsets separately. To save space, we report the results in Table 10 when *NCSKEW* is

Table 7
The regression results controlling for firm fixed effects. This table reports the results from the firm fixed effects regression of the impact of D&O insurance on future stock price crash risk. The dependent variables *NCSKEW* and *DUVOL* are measured over year $t+1$ and defined in models (3) and (4). Reported in parentheses are *t*-values based on robust standard errors clustered by both firm and year. All variables are defined in Appendix A.

	(1)	(2)	(3)	(4)
	$NCSKEW_{t+1}$	$NCSKEW_{t+1}$	$DUVOL_{t+1}$	$DUVOL_{t+1}$
$D\&O_t$	−0.127**	−0.137**	−0.105**	−0.112**
	(−2.48)	(−2.56)	(−2.21)	(−2.28)
$NCSKEW_t$		0.026		0.022
		(0.55)		(0.52)
$OTurnover_t$		0.086		0.107
		(0.81)		(1.09)
$Sigma_t$		1.134		−0.436
		(0.56)		(−0.22)
Ret_t		1.036		1.685
		(0.20)		(0.35)
$Size_t$		0.062**		0.040*
		(2.38)		(1.67)
BM_t		−1.309***		−1.045***
		(−4.80)		(−3.86)
Lev_t		−0.723***		−0.596***
		(−3.18)		(−2.72)
ROA_t		−0.621		−0.545
		(−1.60)		(−1.43)
$AbsACC_t$		0.080		0.053
		(0.31)		(0.22)
Constant	−0.240	−0.836	−0.250	−0.416
	(−1.56)	(−1.48)	(−1.62)	(−0.80)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	Yes	Yes	Yes	Yes
Observations	914	914	914	914
Adjusted R^2	0.050	0.099	0.041	0.076

* Indicates significance at the 10% level (two-tailed).
** Indicates significance at the 5% level (two-tailed).
*** Indicates significance at the 1% level (two-tailed).

adopted to measure stock price crash risk.[6] The estimated coefficient of *D&O* in column (1) is −0.085 and is not significant. In contrast, the coefficient of *D&O* in column (5) is −0.190, significant at the 1% level. This indicates that the effect of D&O insurance on future crash risk is more pronounced in firms with lower board independence.

6.1.2. Big 4 auditors

We divide the sample into two subsets: the firms that appoint Big 4 auditors to provide annual reports auditing service and those that do not appoint Big 4 auditors. Then we re-estimate model (1) with the two subsets separately. To save space, we report the results in Table 10 when *NCSKEW* is adopted to measure stock price crash risk. The estimated coefficient of *D&O* in column (2) is 0.131 and is not significant. In contrast, the coefficient of *D&O* in column (6) is −0.154, significant at the 1% level. This indicates that the effect of D&O insurance on future crash risk is more pronounced in firms that do not appoint Big 4 auditors.

6.1.3. Institutional investors

We divide the sample into two subsets: the higher institutional shareholding subset with the shareholdings above the median of the same year and industry, and the lower institutional shareholding subset with the shareholdings below the median. Then we re-estimate model (1) with the two subsets separately. To save space, we report the results in Table 10 when *NCSKEW* is adopted to measure stock price crash risk. The estimated coefficient of *D&O* in column (3) is −0.098 and is not insignificant. In contrast, the coefficient of *D&O* in column (7) is −0.179, significant at the 5% level. This indicates that the effect of D&O insurance on future crash risk is more pronounced in firms with lower institutional shareholdings.

6.1.4. Investor protection

We use Fan and Wang's index to proxy for investor protection. This index is widely used by prior studies on Chinese capital market (e.g., Wang et al., 2008). We divide the sample into two subsets: the strong protection subset with the index above the median at the same year and within the same province, and the weak protection subset with the index below the median.

[6] We also run the regressions when *DUVOL* is adopted to measure stock price crash risk and get similar results. We adopt the same manner to report the results when we examine the moderating effects of Big 4 auditors, institutional investors, and investor protection. The results are available upon requests.

Table 8
The regression results controlling for some possibly omitted variables. This table reports the results from the ordinary least squares regression of the impact of D&O insurance on future stock price crash risk controlling for some possibly omitted variables. The dependent variables *NCSKEW* and *DUVOL* are measured over year $t+1$ and defined in models (3) and (4). The test variable is *D&O*. In addition to the control variables in model (1), we also include *Cscore* to proxy for accounting conservatism, *DDBT* to proxy for tax avoidance, *lnIC* to proxy for internal control quality, *lnBoardSize* to proxy for board size, *Independence* to proxy for board independence, *Duality* to proxy for the duality of CEOs and board chairmen, *FstHold* to proxy for the largest shareholder's holdings, *InsHold* to proxy for institutional investors' holdings, *Protect* to proxy for investor protection, and *SOE* to proxy for the nature of property right. Reported in parentheses are *t*-values based on robust standard errors clustered by both firm and year. All variables are defined in Appendix A.

	(1)	(2)	(3)	(4)	(5)	(6)
	$NCSKEW_{t+1}$	$NCSKEW_{t+1}$	$NCSKEW_{t+1}$	$DUVOL_{t+1}$	$DUVOL_{t+1}$	$DUVOL_{t+1}$
$D\&O_t$	−0.156***	−0.159***	−0.162***	−0.111***	−0.108**	−0.111***
	(−4.00)	(−3.78)	(−4.25)	(−2.98)	(−2.46)	(−2.85)
$NCSKEW_t$	0.009	0.006	0.001	0.025	0.022	0.016
	(0.13)	(0.08)	(0.01)	(0.41)	(0.37)	(0.27)
$Oturnover_t$	0.059	0.030	0.022	0.081	0.050	0.044
	(0.59)	(0.33)	(0.24)	(0.84)	(0.52)	(0.47)
$Sigma_t$	1.682	1.772	1.563	−0.133	−0.005	−0.224
	(0.83)	(0.80)	(0.67)	(−0.08)	(−0.00)	(−0.11)
Ret_t	4.287	4.260	3.994	5.126	5.339	4.869
	(0.52)	(0.46)	(0.42)	(0.84)	(0.75)	(0.65)
$Size_t$	0.019	0.003	0.017	−0.006	−0.025	−0.013
	(0.68)	(0.08)	(0.51)	(−0.29)	(−1.05)	(−0.44)
BM_t	−0.555***	−0.454***	−0.467***	−0.296	−0.184	−0.188
	(−3.06)	(−3.16)	(−2.74)	(−1.17)	(−0.84)	(−0.84)
Lev_t	−0.327**	−0.186	−0.260	−0.126	0.018	−0.053
	(−2.18)	(−1.24)	(−1.36)	(−0.81)	(0.12)	(−0.29)
ROA_t	0.144	0.516	0.408	0.740	1.048	0.937
	(0.21)	(0.78)	(0.63)	(0.99)	(1.45)	(1.29)
$AbsACC_t$	0.285	0.171	0.238	0.183	0.079	0.152
	(0.73)	(0.43)	(0.55)	(0.56)	(0.23)	(0.40)
$CScore_t$	−0.183	−0.054	−0.068	−0.096	0.027	0.014
	(−0.80)	(−0.23)	(−0.28)	(−0.42)	(0.13)	(0.07)
$DDBT_t$	0.641	0.734	0.664	1.339**	1.414**	1.346**
	(0.86)	(1.04)	(0.94)	(2.27)	(2.47)	(2.35)
$lnIC_t$	−0.030	−0.042	−0.043	−0.004	−0.016	−0.016
	(−0.38)	(−0.58)	(−0.62)	(−0.06)	(−0.22)	(−0.23)
$lnBoardSize_t$		0.192	0.167		0.267	0.240
		(1.06)	(0.98)		(1.39)	(1.27)
$Independence_t$		0.231	0.242		−0.017	−0.018
		(0.46)	(0.47)		(−0.03)	(−0.03)
$Duality_t$		0.044	0.044		0.048	0.048
		(0.37)	(0.39)		(0.53)	(0.58)
$FstHold_t$			−0.181			−0.164
			(−0.86)			(−0.96)
$InsHold_t$			4.846			11.857
			(0.54)			(1.42)
$Protect_t$			−0.164**			−0.155**
			(−2.49)			(−2.49)
SOE_t			−0.004			0.006
			(−0.05)			(0.06)
Constant	−0.783	−0.825	−0.594	−0.605	−0.584	−0.358
	(−1.12)	(−1.54)	(−1.04)	(−1.22)	(−1.15)	(−0.61)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	734	729	729	734	729	729
Adjusted R^2	0.033	0.029	0.027	0.020	0.021	0.020

** Indicates significance at the 5% level (two-tailed).
*** Indicates significance at the 1% level (two-tailed).

Then we re-estimate model (1) with the two subsets separately. To save space, we report the results in Table 10 when *NCSKEW* is adopted to measure stock price crash risk. The estimated coefficient of *D&O* in column (4) is −0.016 and is not significant. In contrast, the coefficient of *D&O* in column (8) is −0.208, significant at the 1% level. This indicates that the effect of D&O insurance on future crash risk is more pronounced in firms with weak investor protection.

Taken the above together, we find that the negative relationship between D&O insurance and crash risk become more pronounced in firms with lower board independence, non-Big 4 auditors, lower institutional shareholdings, and weaker investor protection. The results are consistent with our prediction in that D&O insurers take part in the corporate governance of the insured firms when the monitoring mechanisms of these firms are not effective.

Table 9
The regression results using a bootstrap method. This table reports the results from the ordinary least squares regression of the impact of D&O insurance on future stock price crash risk using a bootstrap method. The dependent variables *NCSKEW* and *DUVOL* are measured over year $t+1$ and defined in models (3) and (4). The test variable is *D&O*. Reported in parentheses are *t*-values based on bootstrap procedure. All variables are defined in Appendix A.

	(1)	(2)	(3)	(4)
	$NCSKEW_{t+1}$	$NCSKEW_{t+1}$	$DUVOL_{t+1}$	$DUVOL_{t+1}$
$D\&O_t$	−0.129***	−0.137***	−0.107**	−0.113**
	(−2.67)	(−2.83)	(−2.30)	(−2.19)
$NCSKEW_t$		0.061		0.064*
		(1.37)		(1.65)
$OTurnover_t$		0.083		0.103
		(0.81)		(1.05)
$Sigma_t$		0.845		−0.748
		(0.42)		(−0.41)
Ret_t		2.543		4.423
		(0.50)		(0.88)
$Size_t$		0.033		0.019
		(1.32)		(0.90)
BM_t		−1.066***		−0.838***
		(−3.78)		(−3.14)
Lev_t		−0.570**		−0.466**
		(−2.43)		(−2.28)
ROA_t		−0.647		−0.587
		(−1.43)		(−1.33)
$AbsACC_t$		0.107		0.088
		(0.34)		(0.30)
Constant	−0.214	−0.270	−0.237	−0.022
	(−1.33)	(−0.53)	(−1.58)	(−0.05)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Observations	914	914	914	914
Adjusted R^2	0.033	0.047	0.031	0.040

* Indicates significance at the 10% level (two-tailed).
** Indicates significance at the 5% level (two-tailed).
*** Indicates significance at the 1% level (two-tailed).

6.2. An alternative explanation: the eyeball effect

Until the end of 2012, 105 listed firms have bought D&O insurance. As there are 2494 A-share listed firms in China's capital market in total by the end of 2012, D&O insured firms account for a very limited percentage. Therefore, they might have become super stars in the capital market and received more attention and monitoring from the public (namely, the eyeball effect). Consequently, it may become more difficult for their management to hide negative news. For this reasoning, we predict that D&O insurance attracts more market attention.

We adopt the number of analysts following the tracks of insured firms to proxy for the market attention on the firms and examine the impact of D&O insurance on the degree of market attention. Following Bhushan (1989) and Yu (2008), we add the following control variables: MKV_t (the natural logarithm of total market value of a firm), ROA_{t-1} (return on assets in prior year), $Growth_t$ (the increase in the percentage of sales), Fin_t (total funds raised from equity and debt divided by total assets in year t), $InsHold_t$ (the percentage of shareholdings held by institutional investors), and $OCFV_t$ (the standard deviation of yearly operating cash flows in prior three years). Year and industry dummies are also added to control for the year and industry effects. The specification of the model is:

$$\text{Analyst}_t = \alpha + \beta_1 D\&O_t + \beta_2 \text{MKV}_t + \beta_3 \text{LROA}_t + \beta_4 \text{Growth}_t + \beta_5 \text{Fin}_t + \beta_6 \text{Fund}_t + \beta_7 \text{OCFV}_t + \text{YR} + \text{Ind} + \varepsilon_t \quad (6)$$

We run the regression of model (6) and the results are reported in Table 11. The coefficients of *D&O* in four columns are all not significant, indicating that firms which purchase D&O insurance do not catch more attention from the capital market. This implies that the negative relationship between D&O insurance and stock price crash risk is not driven by the eyeball effect.

7. Economic mechanisms: internal control quality and corporate social responsibility

Our evidence suggests that firms purchasing D&O insurance tend to have lower stock price crash risk. In this section, we seek to understand the economic mechanisms through which D&O insurance could affect crash risk. As discussed in the literature, internal control quality and the disclosure of corporate social responsibility (CSR) information have significant impacts on crash risk. We explore two possibilities: (1) whether firms purchasing D&O insurance are more likely to improve internal control quality and

Table 10
The moderating effects of monitoring mechanisms on stock price crash risk. This table reports the results of moderating effects of monitoring mechanisms on the relationship between future stock price crash risk and D&O insurance by dividing the full sample into two groups based on these mechanisms, when *NCSKEW* is adopted to measure stock price crash risk. We use four variables to proxy for monitoring mechanisms: the percentage of independent directors, Big 4 auditors, the percentage of institutional shareholdings, and investor protection index. The dependent variables *NCSKEW* is measured over year $t+1$ and defined in model (3). The test variable is *D&O*. Reported in parentheses are *t*-values based on robust standard errors clustered by both firm and year. All variables are defined in Appendix A.

Dependent variable = $NCSKEW_{t+1}$	Stronger monitoring mechanisms				Weaker monitoring mechanisms			
	Higher percentage of independent directors	Big 4 auditors	Higher percentage of institutional shareholdings	Better investor protection	Lower percentage of independent directors	Non Big 4 auditors	Lower percentage of institutional shareholdings	Worse investor protection
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
$D\&O_t$	−0.085	0.131	−0.098	−0.016	−0.190***	−0.154***	−0.179**	−0.208***
	(−0.76)	(1.01)	(−1.15)	(−0.12)	(−2.85)	(−3.40)	(−2.58)	(−3.01)
$NCSKEW_t$	0.013	0.079	0.087	0.095	0.043	0.035	0.073	0.016
	(0.12)	(0.56)	(1.37)	(1.01)	(0.58)	(0.60)	(0.80)	(0.23)
$OTurnover_t$	0.275**	0.120	0.154	0.074	0.001	0.067	0.080	0.180*
	(2.22)	(0.38)	(1.20)	(0.37)	(0.01)	(0.49)	(0.68)	(1.83)
$Sigma_t$	−0.291	7.549	−0.810	−2.785	1.906	0.999	−0.336	2.338
	(−0.08)	(1.07)	(−0.24)	(−1.17)	(0.69)	(0.46)	(−0.14)	(1.01)
Ret_t	3.273	−3.640	7.371	23.064***	−0.626	3.142	5.193	−4.653
	(0.64)	(−0.23)	(0.96)	(2.76)	(−0.07)	(0.53)	(0.67)	(−0.61)
$Size_t$	0.048***	−0.105**	−0.006	0.058*	0.021	0.069***	0.063**	0.003
	(2.86)	(−2.07)	(−0.26)	(1.73)	(0.61)	(4.95)	(2.12)	(0.22)
BM_t	−1.133	−1.892***	−0.590	−1.110**	−1.137***	−1.125***	−1.431***	−1.140***
	(−1.62)	(−2.88)	(−1.13)	(−2.54)	(−3.19)	(−3.62)	(−4.08)	(−2.94)
Lev_t	−0.642	−1.515***	−0.523	−0.288	−0.619*	−0.643***	−0.673*	−0.839***
	(−1.36)	(−2.78)	(−1.56)	(−0.67)	(−1.88)	(−2.60)	(−1.96)	(−3.12)
ROA_t	−0.806*	1.381	−1.481*	−1.276	−0.585	−1.114***	−0.290	−0.877*
	(−1.78)	(0.89)	(−1.94)	(−1.28)	(−0.80)	(−3.44)	(−0.50)	(−1.82)
$AbsACC_t$	0.162	0.257	−0.078	0.716*	0.441	0.118	0.153	−0.291
	(0.38)	(0.28)	(−0.21)	(1.97)	(1.57)	(0.57)	(0.31)	(−1.20)
Constant	−2.025***	3.465***	0.067	−1.256***	−0.347	−0.335	0.146	1.116***
	(−2.96)	(4.91)	(0.12)	(−4.71)	(−0.51)	(−0.97)	(0.31)	(2.86)
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Observations	302	166	430	251	561	748	484	663
Adjusted R^2	0.032	0.116	0.015	0.066	0.035	0.048	0.116	0.067

* Indicates significance at the 10% level (two-tailed).
** Indicates significance at the 5% level (two-tailed).
*** Indicates significance at the 1% level (two-tailed).

enhance financial reporting quality; and (2) whether D&O insurance improve the disclosure of the non-financial information (i.e., CSR). These two factors directly and adversely affect the crash risk and, as such, could be viable mechanisms by which D&O insurance influences crash risk.

7.1. D&O insurance and internal control quality

Following Hu et al. (forthcoming), we use financial restatements to measure internal control quality. A voluntary or enforced restatement of a financial statement suggests problems in the financial reporting and this could be symptomatic of poor underlying internal control (Krishnan and Visvanathan, 2007). Moreover, some studies demonstrate a significant relationship between internal control deficiencies and the likelihood of financial restatements (Ashbaugh-Skaife et al., 2007; Plumlee and Yohn, 2010).

Financial restatement announcements are manually collected from the Wind database. We follow the method in Lin et al. (2013) and exclude the restatements arising from accounting standard changes and other normal restatements required for the comparability of financial statements (e.g., the requirement of the stock exchanges). This process results in 756 usable observations.

We use a probit regression to examine the effect of D&O insurance on the probabilities of financial restatements. The dependent variable is *Restate*, a dummy variable that equals 1 if a firm announces a financial restatement, 0 otherwise. Following prior studies (e.g., Burns and Kedia, 2006; Palmrose and Scholz, 2004), we control for the following variables as proxies for corporate governance: *Independence* (the proportion of independent directors on a board), *FstHold* (the proportion of shares held by the largest shareholder), and *SOE* (a dummy variable that equals 1 if the ultimate controlling shareholder of a listed firm is the state, 0 otherwise). Also, we add some firm characteristic variables, including firm profitability (*ROA*), sales growth (*Growth*), leverage (*Lev*), and firm size (*Size*). In addition, we include year and industry dummies to control for the year and industry fixed effects.

Table 11
The regression results examining the eyeball effect. This table reports the results from the probit regression of the impact of D&O insurance on the (future) number of analyst following the purchase of this insurance. The dependent variable is *Analys* and the test variable of is *D&O*. Reported in parentheses are *t*-values based on robust standard errors clustered by both firm and year. All variables are defined in Appendix A.

	(1)	(2)	(3)	(4)
	$Analyst_t$	$Analyst_t$	$Analyst_{t+1}$	$Analyst_{t+1}$
$D\&O_t$	−0.087	0.184	−0.084	0.056
	(−1.38)	(1.34)	(−0.66)	(0.32)
MKV_t	0.502***	0.573***	0.537***	0.213**
	(7.64)	(5.67)	(6.69)	(1.99)
ROA_{t-1}	2.944***	1.304	2.749**	0.400
	(3.26)	(1.34)	(1.98)	(0.43)
$Growth_t$	0.429**	0.229	0.127	0.057
	(2.39)	(1.34)	(0.58)	(0.25)
Fin_t	−0.163	−0.702	−0.278	−0.235
	(−0.42)	(−1.63)	(−0.74)	(−0.40)
$InsHold_t$	0.513**	0.581**	0.378	−0.060
	(2.42)	(2.13)	(1.00)	(−0.17)
$OCFV_t$	−1.222**	0.109	−0.521	0.976
	(−2.07)	(0.11)	(−0.35)	(0.78)
Constant	−6.814***	−8.424***	−6.951***	−1.632
	(−6.04)	(−5.12)	(−4.96)	(−1.04)
Year fixed effects	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes
Firm fixed effects	No	Yes	No	Yes
Observations	903	903	480	480
Adjusted R^2	0.676	0.562	0.629	0.363

** Indicates significance at the 5% level (two-tailed).
*** Indicates significance at the 1% level (two-tailed).

The empirical results are presented in Table 12. The coefficient of *D&O* is significantly and negatively related with *Restate* at the 5% level. This suggests that D&O insurance purchase can reduce the probabilities of financial restatements, therefore, decreasing stock price crash risk.

Table 12
D&O insurance and financial restatements. This table reports the results from a probit regression of the impact of D&O insurance on financial restatements. The dependent variable is *Restate* and the test variable is *D&O*. Reported in parentheses are *t*-values based on robust standard errors clustered by both firm and year. All variables are defined in Appendix A.

	(1)	(2)
	$Restate_t$	$Restate_t$
$D\&O_t$	−0.197**	−0.244**
	(−2.02)	(−2.56)
$FstHold_t$		−0.002
		(−0.43)
$Independence_t$		2.742**
		(2.43)
Lev_t		0.690*
		(1.66)
$Size_t$		−0.161**
		(−2.29)
$Growth_t$		−0.150
		(−1.01)
ROA_t		−0.715
		(−1.15)
SOE_t		0.090
		(0.64)
Constant	−1.152***	1.156
	(−7.70)	(0.87)
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Observations	756	756
Pseudo R^2	0.005	0.060

* Indicates significance at the 10% level (two-tailed).
** Indicates significance at the 5% level (two-tailed).
*** Indicates significance at the 1% level (two-tailed).

7.2. D&O insurance and corporate social responsibility

If insurance companies play a role in corporate governance as we suggested, they may require the D&O insured firms to disclose more information (including financial and non-financial information) to keep a higher level of transparency. As China's listed firms are required to disclose financial information, they will choose to disclose non-financial information to satisfy the insurers. CSR information is an important kind of non-financial information. Previous studies have demonstrated that the disclosure of CSR information can improve information transparency (Gelb and Strawser, 2001; Kim et al., 2012) and then reduce stock price crash risk (Kim et al., 2014). Therefore, we predict that D&O insured firms are more likely to disclose CSR reports.

We use a probit model to examine this prediction. The dependent variable is *CSR*, a dummy variable that equals 1 if a firm discloses a separate CSR report in a year and 0 otherwise. We control for several factors that have been shown to affect the disclosure of CSR information in prior studies (e.g., Dhaliwal et al., 2011): *Donation* (firm's charitable donation, a proxy for firms' social performance), *Size* (firm size), *ROA* (profitability), *Lev*(leverage), *Fin* (total funds raised through equity and debt divided by total assets), *Tobin's Q* (growth opportunities), *Liquidity* (the ratio of the number of shares traded in the year to the total shares outstanding at the year-end), *Competition* (industry competition, measured as the sales Herfindahl index multiplied by −1), and *Big4* (a dummy variable that equals 1 if the firm hires an international Big4 accounting firm in year t and 0 otherwise). We also add two variables of financial disclosure quality, *AbsACC* (the absolute value of discretionary accruals from the modified Jones model multiplied by −1) and *CIG* (a dummy variable that equals 1 if a firm issues at least one earnings forecast in the year and 0 otherwise).

The empirical results are reported in Table 13. The coefficient of *D&O* is significantly and negatively related with *CSR* at the 5% level. This suggests that D&O insurance purchase can improve the disclosure of CSR information, thus reducing stock price crash risk.

Table 13
D&O insurance and corporate social responsibility. This table reports the results from a probit regression of the impact of D&O insurance on corporate social responsibility. The dependent variable is *CSR* and the test variable is *D&O*. Reported in parentheses are *t*-values based on robust standard errors clustered by both firm and year. All variables are defined in Appendix A.

	(1)	(2)
	CSR_t	CSR_t
$D\&O_t$	0.315**	0.446***
	(2.22)	(3.58)
$Donation_t$		0.017
		(1.60)
$Competition_t$		−0.514***
		(−3.71)
$Big4_t$		−0.427
		(−1.09)
Fin_t		2.917***
		(3.31)
$Tobin's\ Q_t$		0.080
		(0.76)
$Size_t$		0.570***
		(3.67)
Lev_t		−1.108
		(−1.32)
ROA_t		7.295***
		(5.29)
$Liquidity_t$		0.022
		(0.34)
$AbsACC_t$		−0.591
		(−0.50)
CIG_t		−0.567**
		(−2.54)
Constant	−0.099	−12.975***
	(−0.29)	(−3.75)
Year fixed effects	Yes	Yes
Industry fixed effects	Yes	Yes
Observations	408	408
Pseudo R^2	0.219	0.390

** Indicates significance at the 5% level (two-tailed).
*** Indicates significance at the 1% level (two-tailed).

Overall, these results bolster our findings and help explain the link between D&O insurance and stock price crash risk. D&O insurance purchase appears to be associated with less financial restatements (Table 12) and more disclosure of CSR information (Table 13).

8. Conclusions

Using a unique data set of corporate purchases of D&O insurance by China's listed firms, we examine the impact of D&O insurance on stock price crash risk. We find that the purchase of D&O insurance is negatively associated with stock price crash risk after controlling for other predictors of crash risk, suggesting that the purchase of D&O insurance reduces stock price crash risk and appears to improve corporate governance. Further analyses show that the impact of D&O insurance on future crash risk is more pronounced in firms with lower board independence, non-Big 4 auditors, lower institutional shareholdings, and weaker investor protection. Moreover, we find two channels through which D&O insurance reduces stock price crash risk: internal control quality and corporate social responsibility information.

Overall, our findings provide support to the notion that D&O insurance appears to improve corporate governance. This is different from those that undertaken under the context of developed capital markets. In countries like Canada, the U.S., and the U.K., public firms are under rigorous regulations from various parties, the impact of D&O insurers on the corporate governance of insured firms are proved to be negative (see the discussion in Section 1). While in developing regions, such as China, where the regulations on public firms and the legal environment are much weaker, the leverage effect of insurance premiums becomes pronounced. A little monitoring from D&O insurers can reduce the risks of being claimed in a greater degree. Therefore, under the monitoring of D&O insurers, managers in the D&O insured firms in China show a lower tendency to conceal bad news, leading to lower stock price crash risk.

Our study adds to the growing literature on D&O insurance and its implications on firms and investors. We focus on the role of D&O insurance in reducing crash risk and provide new evidence on the economic consequences of D&O insurance. We also extend prior studies on crash risk by identifying a new factor that has an incremental mitigating effect on future stock price crash risk. Our results are beneficial to firms and investors who want to manage crash risk in the stock market. Our findings also have important policy implications. As information about D&O insurance has a significant impact on stock price crash risk, China's securities regulators should consider mandating the disclosure of D&O insurance information by listed firms.

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Appendix A. Variable definitions

This table contains the definitions of variables used in our analysis. All continuous variables are winsorized at 1% at both tails.

Crash risk variable	
$NCSKEW_{t+1}$	The negative skewness of firm-specific weekly returns in year $t+1$, calculating by taking the negative of the third moment of firm-specific weekly returns for each sample year and dividing it by the standard deviation of firm-specific weekly returns raised to the third power. See model (3) for details.
$DUVOL_{t+1}$	The down-to-up volatility. For any stock i in year t, we separate all the weeks with firm-specific weekly returns below the annual mean (down weeks) from those with firm-specific weekly returns above the period mean (up weeks) and compute the standard deviation for each of these subsamples separately. We then take the log of the ratio of the standard deviation of the down weeks to the standard deviation of the up weeks. See model (4) for details.
D&O variable	
$D\&O_t$	A dummy variable that equals 1 if a firm purchases D&O insurance in year t and 0 otherwise
Other variables	
$AbsACC_t$	The absolute value of the estimated residuals from the adjusted-Jones model (Dechow et al., 1995)
$Analyst_t$	The natural logarithm of the sum of the number of analysts plus 1 in year t
$Balance_t$	The ratio of the sum of the shareholdings held by the second to the fifth largest shareholders divided by the shareholdings held by the largest shareholder in year t
$Big4_t$	A dummy variable that equals 1 if the firm hires an international Big 4 accounting firm in year t and 0 otherwise
BM_t	Book-to-market ratio, calculated by the book value of equity divided by the market value of equity in year t

Appendix A (*continued*)

Crash risk variable	
CIG_t	A dummy variable that equals 1 if the firm issues at least one earnings forecast in the year t and 0 otherwise
$Competition_t$	The Herfindahl index multiplied by −1. The Herfindahl index is computed as the sum of the squared fraction of sales of the firms in an industry in year t
$CrossList_t$	A dummy variable that equals 1 if a firm is cross-listed in oversea exchanges in year t and 0 otherwise
$CScore_t$	Proxy for accounting conservatism following Khan and Watts (2009)
CSR_t	A dummy variable that equals 1 if the firms that issued a standalone CSR report in year t and 0 otherwise
$DDBT_t$	The discretionary book-tax difference following Desai and Dharmapala (2006)
$Donation_t$	The amount of donation of the firm in year t, defined as the natural logarithm of one plus the amount of donation
$Duality_t$	A dummy variable that equals 1 if the CEO and chairman are the same person in year t and 0 otherwise
Fin_t	Total funds raised through equity and debt divided by total assets in year t
$FstHold_t$	The percentage of shares owned by the largest shareholder in year t
$InsHold_t$	The percentage of shares owned by institutional investors in year t
$Growth_t$	The increased percentage of sales growth in year t
$IndAvg\_D\&O_t$	The mean incidence of D&O insurance purchase for firms in the same industry in the same year, excluding the firm concerned
$Independence_t$	The proportion of independent directors on a board in year t
Lev_t	Firm financial leverage, calculated by the book value of total debt divided by the book value of total assets in year t
$Liquidty_t$	The ratio of the number of shares traded in the year to the total shares outstanding at the fiscal year t end
$lnBoardSize_t$	The natural logarithm of the number of board directors in a board in year t
$lnIC_t$	The natural logarithm of one plus the China internal control quality index in year t
$ManHold_t$	The proportion of shares held by top executives in year t
MKV_t	The natural logarithm of total market value of a firm in year t
$OCFV_t$	The standard deviation of yearly operating cash flows in prior three years
$Oturnover_t$	The detrended average monthly stock turnover in year t, calculated as the average monthly share turnover in year t minus the average monthly share turnover in year $t-1$
$Protect_t$	The natural logarithm of provincial investor protection index in year t
$Restate_t$	A dummy variable that equals 1 if a firm announces a financial restatement in year t and 0 otherwise
Ret_t	The mean of firm-specific weekly returns over the fiscal year t
ROA_t	Return on assets, calculated by net profit divided by the book value of total assets in year t
$Sigma_t$	The standard deviation of firm-specific weekly returns over the fiscal year period t
$Size_t$	The natural logarithm of the book value of total assets in year t
SOE_t	A dummy variable that equals 1 if the ultimate controlling shareholder of a listed firm is the state in year t and 0 otherwise
$Tobin's\ Q_t$	The sum of equity capitalization and debt capitalization divided by total assets at the fiscal year t end
$Violation_t$	A dummy variable that equals 1 if a firm has a violation record in year t and 0 otherwise

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