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Directors' and officers' liability insurance and investment efficiency: Evidence from Taiwan

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ABSTRACT

Prior studies suggest that directors' and officers' (D&O) insurance induces moral hazard and reduces incentives on behalf of stockholders. As a result, we argue that purchasing D&O insurance exhibits lower investment efficiency. Using data from Taiwan between 2008 and 2010, which is mandatorily disclosed and thus serves as an ideal sample, we test for an adverse relation between D&O insurance and investment efficiency and explore factors that affect the magnitude of that adverse relation. The results show that the level of D&O insurance coverage is positively associated with over-investment. Further analyses suggest that the positive association is more pronounced in firms with lower levels of director ownership or institutional holdings and weakened when firms purchase from domestic rather than foreign insurers. Overall, we conclude that D&O insurance has an impact on corporate investment decisions, especially in terms of over-investment, and that better corporate governance mechanisms help mitigate the inefficiency problems caused by D&O insurance.

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1. Introduction

The use of directors' and officers' (hereafter D&O) insurance is now widespread in North America, Western Europe, and Asia, and this market around the world, estimated by Allianz Global Corporate & Specialty, is worth $10 billion in written premiums.[2] D&O insurance policies offer liability cover for executives to protect them from claims that may arise from the decisions made and actions taken within the scope of their regular duties. Thus, D&O insurance helps in recruiting and retaining excellent directors and allows directors and officers to take appropriate actions for the benefit of shareholders. However,

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giant Berkshire Hathaway, the eighth largest public enterprise in the world, does not provide liability insurance for its own directors. Warren Buffett, the company's chairperson and CEO, stated, "We do not provide them directors and officers liability insurance, a given at almost every other large public company. If they mess up with your money, they will lose their money as well."[3]

Recent studies have responded to Buffett's statement and provided valuable insights into the role of D&O insurance. They have examined the association between D&O insurance and (1) post-IPO stock performance, (2) stock performance following merger and acquisition (M&A) acquisition announcements, and (3) financial reporting decisions and suggested that D&O insurance causes managers to engage in excessive risk-taking at the expense of the firm or to report financial performance aggressively because the managers' expected legal liability is reduced via D&O insurance (Chalmers and Harford, 2002; Chung and Wynn, 2008; Lin et al., 2011; Wynn, 2008). In addition, investors perceive D&O insurance negatively, and firms with high D&O insurance coverage experience high capital costs (Chen et al., 2012; Lin et al., 2013). While most studies have indicated that D&O insurance induces severe moral hazard from the investors' perspective, little is known about whether D&O insurance has an adverse effect on internal corporate decisions. Accordingly, this study extends this research stream to capital investment decisions and provides the first empirical evidence on three important research questions: (1) whether an association between D&O insurance coverage and investment efficiency exists; (2) whether a positive association between D&O insurance coverage level and investment inefficiency exists and whether that association is more pronounced for firms with a low level of director ownership or institutional holdings; and (3) whether the characteristics of insurers affect the association between investment efficiency and D&O insurance.

These research questions are important on several grounds. First, we focus on investment efficiency because prior studies argue that agency problems may cause managers to implement inefficient investment decisions (e.g., Jensen, 1986; Lambert et al., 2007; Myers and Majluf, 1984). In addition, firm value is enhanced by investing efficiently in productive assets (Stulz, 2000). Managerial opportunism in investment decisions encompasses over-investment and under-investment; the former refers to a situation in which some positive net present value projects are foregone, and over-investment is a situation in which some negative net present value projects are undertaken. This study will provide evidence of both.

Second, although prior studies have argued that D&O insurance enhances opportunistic managerial behavior, it remains unresolved whether there exists a disciplinary measure to mitigate such moral hazard. We fill this gap by focusing on the internal corporate governance mechanism represented by ownership, which is generally contended to affect corporate investment efficiency. More specifically, it is well-documented that the agency problem that arises when executives hold only a fraction of the ownership shares of the firm (Jensen and Meckling, 1976) can be alleviated by increasing directors' ownership to align the interests of managers with those of shareholders (Jensen and Meckling, 1976; Ferreira and Matos, 2008; Francis and Smith, 1995; Richardson, 2006),or enhancing shareholders' monitoring function, a role that is usually played by institutional investors (e.g., Agrawal and Mandelker, 1990, 1992; Bushee, 1998; Shleifer and Vishny, 1986). In combination, we investigate how the ownership structure affects the relation between D&O insurance and investment efficiency.

Third, two competing hypotheses about D&O insurance have been studied in the literature. The first is the opportunism hypothesis, which posits that directors and officers do not behave in the interests of shareholders since their potential liability can be covered by D&O insurance. The second one is the monitoring hypothesis, which argues that firms buying D&O insurance are screened thoroughly by insurers, and as a result, D&O insurance helps ensure that directors pursue the interests of shareholders (Holderness, 1990; O'Sullivan, 1997). Most empirical studies have been supportive of the opportunism hypothesis. However, this does not refute the existence of the monitoring role of D&O insurance. Baker and Griffith (2006) argue that the absence of monitoring is due to a lack of adequate knowledge and experience on the part of the insured. Otherwise, compared to local insurers, foreign insurers take low pricing strategies instead of a product differentiation strategy to increase market share (Choi and Elyasiani, 2011). This study, therefore, informs the debate by providing a deeper analysis of the question of whether the monitoring effect is merely theory-oriented or is driven by the characteristics of insurers.

We focus on firms listed on the Taiwan Stock Exchange (TWSE) and the GreTai Securities Market (GTSM) between 2008 and 2010 because disclosures of D&O insurance have been publicly available since

[3] Refer to http://www.insurancejournal.com/news/national/2011/02/28/188339.htm.

2008. Following prior studies, we estimate the normal investment level and then calculate the deviation from the normal investment level in the following year (Biddle et al., 2009; Chen et al., 2011). As for D&O insurance policies, we use D&O insurance coverage as a proxy for managerial opportunism related to expected liability (e.g., Wynn, 2008). Thus, a higher D&O insurance coverage limit means lower ex ante legal liability for managers. We find robust evidence of a positive association between D&O insurance coverage limits and over-investment. This evidence suggests that firms whose managers are protected under higher D&O insurance coverage are more likely to exhibit more severe over-investment problems. Based on further analyses, we find that the positive association between D&O insurance coverage and over-investment is weaker for firms with higher levels of director ownership or institutional holdings. In addition, managers are less likely to behave opportunistically when the insurers are domestic insurance companies. Overall, these results are consistent with the managerial opportunism hypothesis.

Our study contributes to the literature in several ways. First, this paper is the first to provide direct empirical evidence regarding how D&O insurance affects the managerial decisions. Although prior studies have documented that a relatively higher level of D&O insurance coverage is considered to be riskier by investors, or associated with lower earnings quality (Chung and Wynn, 2008; Lin et al., 2011; Wynn, 2008), our testing that focuses on the effect of D&O on the efficiency of internal capital allocation appears to give a more direct answer to the question of whether the D&O insurance reduces managerial efforts. This finding that presents the direct negative consequence of high D&O insurance coverage, which has been suggested but not directly documented by earlier or concurrent work, enriches this strand of literature and contributes to the ongoing debate over the merits of D&O insurance.

Second, our evidence adds to a deeper understanding of the intended role of D&O insurance, monitoring, by examining whether the adverse effect of D&O insurance on investment efficiency is less pronounced if the D&O insurer is domestic-owned. Prior studies have argued that insurers fail to monitor effectively because they lack knowledge and experience or face distance, linguistic, or cultural barriers (e.g., Baker and Griffith, 2006; Lensink et al., 2008; Vander, 1996). However, little evidence exists to support this argument. As far as we know, this paper represents the first attempt to examine empirically how the characteristics of insurers affect the validity of monitoring of D&O insurance.

Third, the existing literature is almost exclusively based on Canadian data, while few studies, if any, have examined how the D&O insurance influences the firms in the emerging markets. Because the legal system is usually considered less efficient in protecting the welfare of investors in the Asia-Pacific region, the degree to which the D&O insurance exacerbates the moral hazard problem may be severer under this context. Our findings based on Taiwan data timely ascertain that conjecture and considering that the D&O insurance has gained increasing acceptance in the Asia-Pacific area, these evidence will have more direct implications to the capital market and regulators in this region.

The rest of the paper proceeds as follows. The next section provides a brief discussion of related studies and develops the hypotheses. Section 3 describes the data, our variables, and empirical models. Section 4 discusses our main empirical results and provides the results of supplemental analyses, and Section 5 offers a summary and concluding remarks.

2. Previous studies and hypothesis development

To protect directors and officers from personal liability incurred by business decisions and to recruit highly qualified individuals, companies commonly bear the costs of litigation against directors and officers through D&O insurance and indemnification provisions. Specifically, D&O insurance coverage usually (1) reimburses the firm for its indemnification payment for directors and officers, (2) covers individual directors and officers for their wrongful acts to the extent that they have not been indemnified by the firm, or (3) covers the firm to the extent that it is named as a defendant along with the directors and officers. Typical D&O policies cover damages, settlements, judgments, and litigation expenses but not civil or criminal fines or penalties, punitive damages, or multiple damages. Previous studies on the effect of D&O policies on agency costs appear to be mixed. For instance, Bhagat et al. (1987) indicate that D&O insurance reduces the agency conflict between shareholders and managers by adding convexity to a risk-averse manager's utility function. Yermack (1996) and O'Sullivan (2002) argue that the insurer plays a monitoring role and motivates the board and executives to exert more effort. In contrast, some contend that D&O insurance insulates directors and officers from the threat of litigation and personal financial liability resulting

from their decisions on behalf of the corporation, so D&O insurance may induce moral hazard and reduce managers' incentive to act in the best interests of stakeholders (Gutierrez, 2003; Kim, 2006; Lin et al., 2011). For instance, Boubakri et al. (2008) find that managers are more willing to engage in opportunistic behavior when they are covered by a relatively higher D&O insurance limit, whereas Chung and Wynn (2008) indicate that the higher the D&O coverage is, the less conservative the firm's earnings are.

In summarizing the above findings, it appears that the fundamental question—whether D&O liability insurance effectively reduces agency cost—remains unanswered. In particular, this study aims to address this question by testing the relation between a firm's investment efficiency and the coverage amount of D&O insurance. We predict that D&O insurance adversely affects the level of effort and prudence when the board and executives make investment decisions for two reasons. First, the major role that an insurer plays is twofold: to charge D&O premiums that approximate the risk of the insured (Core, 1997) and to make indemnity payments in case of any litigation. It is unlikely for insurers to influence directly the decision making of the general operation of the insured firm, and it is also questionable whether insurers possess thorough understanding and experience in evaluating the competence of the executives and officers of the insured firms (Baker and Griffith, 2006). Consequently, the positive effect of D&O insurance from the insurer's playing the monitoring role may not be effectively attained. Second, the conjecture that the negative effect of D&O insurance prevails is indirectly or partially supported by some studies. Chalmers and Harford (2002), using proprietary information from U.S. firms, indicate that three-year post-IPO performance is negatively associated with D&O insurance coverage purchased, along with the initial public offering IPO. Lin et al. (2011) examine the effect of D&O insurance on the outcomes of merger and acquisition decisions and find that acquirers whose executives have a higher level of D&O insurance coverage experience significantly lower abnormal announcement-period stock returns. They also show that acquirers with a higher level of D&O insurance protection tend to pay higher acquisition premiums and that their acquisitions appear to exhibit lower synergies. In addition, focusing on a sample comprised of Canadian unit trust companies, Boyer (2007) shows that D&O coverage has a negative impact on the growth of the income trust's cash flows. Taken together, the moral hazard effect of D&O should be more pronounced, which leads to insufficient levels of effort or prudence when the board and executives make investment decisions (Jou and Lee, 2004; Richardson, 2006). Therefore, we propose the following hypothesis:

Hypothesis 1. D&O insurance is adversely related to investment efficiency.

Considering that D&O insurance has gained growing acceptance recently (Allianz, 2010), it is crucial to understand what factors mitigate its adverse impact on investment efficiency. Theoretically, when executives and officers suffer more severely from their negligent decision-making, the moral hazard effect of D&O insurance should be smaller. In particular, because typical D&O clauses specify that a D&O policy does not cover fraudulent, criminal, or intentional non-compliant acts (Allianz, 2010), it follows that the eventual amount of indemnity is still, to some degree, at the insurer"s discretion, and the indemnity may not cover all of the losses incurred by the insured firm. More specifically, we posit that the higher the director and officer equity holdings are, the smaller the moral hazard impact of D&O insurance will be because the directors" and officers" interests are more tightly tied to those of the firm (Hudson et al., 1992; Jensen and Meckling, 1976; Singha and Davidson, 2003). In addition, executives and officers are more likely to refrain from negligent decision-making when the knowledgeable party is powerful. Extant studies have documented that institutional ownership involves sophisticated investment skills to monitor and discipline managers efficiently (Chung et al., 2002; Hartzell and Starks, 2003) and thus may facilitate the improvement of firms' internal control systems (Tang and Xu, 2010). Therefore, institutional investors generally can understand the details of D&O clauses and evaluating their effectiveness in inducing executives' and officers' effort. Taken together, the above analyses lead to the following hypotheses:

Hypothesis 2(a). The adverse effect of D&O insurance on investment efficiency is lower for firms with higher director ownership.

Hypothesis 2(b). The adverse effect of D&O insurance on investment efficiency is lower for firms with higher institutional ownership.

Although the monitoring effect of D&O insurance is built on the assumption that the firm will benefit from the insurer undertaking the ex ante underwriting and rating process (e.g., Chen and Chang, 2011; O'Sullivan,

1997), only a very few studies have examined whether insurer characteristics influence the effectiveness of D&O insurance. Broadly speaking, if an insurer is more knowledgeable about the insured firm, it is more likely for the insurer correctly to set a D&O premium that facilitates the maximization of directors' and officers' efforts. Otherwise, Baker and Griffith (2006) claim that D&O insurance companies fail to monitor competently because they do not employ people with the requisite knowledge and experience. In particular, one of the most distinct characteristics of insurers is the domicile status—whether an insurer is domestic- or foreign-owned. Existing literature on the comparative edge of domestic and foreign insurers is sparse, but indirect evidence is available. General industry research indicates that domestic investors have an edge over foreign investors in trading domestic stocks (Agarwal et al., 2009; Chan et al., 2007; Choe et al., 2005), suggesting that local knowledge is crucial in any business discipline. Using data from U.S. property-liability insurers between 1992 and 1998, Choi and Elyasiani (2011) analyze the strategy applied by foreign insurers to expand their market share in the U.S. Their results indicate that foreign-owned insurers mainly increase their market share by lowering prices below competitive levels instead of by providing broader and higher-quality services. In other words, because some foreign-owned insurers can count on the advantage of a scale economy, it may not be necessary for them to gain a thorough understanding of the industry before underwriting a policy. In contrast, domestic-owned insurers often have more years of experience, a deeper understanding of the local culture, and more established relationships with customers, suppliers, and other stakeholders (Skipper, 1997). Taken together, such expertise would give the domestic-owned insurers a greater advantage in detecting the opportunism of directors and officers during the D&O insurance underwriting process. Based on the above argument, the following hypothesis is put forward:

Hypothesis 3. The adverse effect of D&O insurance on investment efficiency is less pronounced if the D&O insurer is domestic-owned.

3. Empirical work

3.1. Data and sample selection

We focus on firms listed on the Taiwan Stock Exchange and the GreTai Securities Exchange from 2008 to 2010. Our sample period starts in 2008 because this was the first year that Taiwan mandated the disclosure of D&O insurance purchases in annual corporate filings. The end year of the sample period is 2010 because we need to evaluate the investment efficiency in the following year, and the data for 2012 are not available yet. All non-financial firms in the *Taiwan Economic Journal* (TEJ) database are included in the initial sample. After dropping observations that lacked sufficient financial or corporate governance data, we obtained 3356 firm-year observations.

3.2. Basic empirical model

Following Biddle et al. (2009) and Chen et al. (2011), Model 1 is used to estimate the normal level of investment and then calculate the deviation from expected investment to evaluate the magnitude of inefficiency. The investment level (*INVEST*) in the following year, including the purchase of property, plant, and equipment and expenditure on research and development, less the disposal of property, plant, and equipment, is a function of revenue growth (*Growth*) in the current year. In addition, we add a dummy variable (*NEG*) to capture the differential predictability because there are asymmetric effects of positive and negative revenue growths on investment level. We estimate the normal investment level by industry-specific cross-sectional regressions and require at least 10 industry-year observations for each industry in a given year. Model 1 shows the following:

$$INVEST_{i,t+1} = \alpha_0 + \alpha_1 NEG_{i,t} + \alpha_2 Growth_{i,t} + \alpha_3 NEG \times Growth_{i,t} + \varepsilon_{i,t} \quad (1)$$

where:

INVEST The sum of new purchases of property, plant, and equipment (PPE) and the research and development expenditure, less the sale of property, plant, and equipment (PPE) in the following year, scaled by average total assets

NEG A dummy variable that is equal to 1 if the revenue growth ratio is negative in the current year and 0 otherwise
Growth Growth rate of net sales over the previous year.

We define the residuals from estimating Model 1 as investment inefficiency (*INVEFF*). Because investment inefficiency includes over-investment and under-investment scenarios, we define observations with positive residuals from the investment efficiency estimation model as an over-investment group (*OVI*) and use the absolute value of negative residuals for under-investment (*UNI*).

Hypothesis 1 predicts that firms with higher D&O insurance coverage will be more likely to over-invest or under-invest. The model shows the following:

$$OVI_{i,t+1} \text{ or } UNI_{i,t+1} = \beta_0 + \beta_1 DOICOV_{i,t} + \beta_2 Size_{i,t} + \beta_3 Age_{i,t} + \beta_4 TANG_{i,t} + \beta_5 Slack_{i,t} + \text{Year fixed effects} + \text{industry fixed effects} \quad (2)$$

where

OVI or *UNI* The residuals from Model 1
DOICOV The firm's total D&O coverage limit, scaled by average total assets
Size The natural logarithm of total assets
Age The firm age
TANG Asset tangibility, measured as the fixed assets to average total assets
Slack Financial slack, measured as the sum of cash and short-term investment to average total assets.

Following Wynn (2008), we define *DOICOV* as the total dollar amount of coverage scaled by average total assets. A high *DOICOV* means that directors and officers bear a lower ex ante legal liability. Several control variables are included in the models to reduce the possibility that investment efficiency is a function of correlated omitted variables and to improve comparability with prior studies. We include firm size (*Size*), firm age (*Age*), asset tangibility (*TANG*), and financial slack (*Slack*) as control variables for financial resources or financial constraints (see also Chen et al., 2011). Finally, to address potential year- and firm-specific effects, two dummy variables, *YEAR* and *INDUSTRY*,[4] are included in Model 2.[5]

Hypothesis 2(a), Hypothesis 2(b), and Hypothesis 3 predict that the adverse effect of D&O insurance on investment efficiency is lower for firms with higher director ownership or higher institution ownership or firms buying D&O insurance from domestic-owned insurers. Thus, we use interaction terms that indicate the impact of directors' ownership, institutional investors, and types of insurance companies on the effectiveness of D&O insurance in enhancing firms' investment efficiency. We predict that the coefficient β_3 will have a negative sign, as these variables mitigate the adverse effect of D&O insurance on firms' investment efficiency. The estimation models show the following:

$$OVI_{i,t+1} \text{ or } UNI_{i,t+1} = \beta_0 + \beta_1 DOICOV_{i,t} + \beta_2 DS\_OWN_{it} + \beta_3 DOICOV_{i,t} \cdot DS\_OWN_{it} + \beta_4 Size_{i,t} + \beta_5 Age_{i,t} + \beta_6 TANG_{i,t} + \beta_7 Slack_{i,t} + \text{Year fixed effects} + \text{Industry fixed effects} \quad (3)$$

[4] The industry sectors are added using the *Taiwan Economic Journal* (TEJ) industry code.

[5] One may be concerned with the potential for endogeneity. We do some work to mitigate any concern that investment inefficiency and D&O insurance decisions are endogenously determined. Notably, our original specification examines the effect of current D&O insurance policies on one-year-ahead investment efficiency. That specification ensures at least partially that our results are not driven by reverse causality (e.g., Chen et al., 2011; Lin et al., 2013). Still, we check the reverse causality by performing a Durbin–Wu–Hausman test (Durbin, 1954; Wu, 1973; Hausman, 1978). In the first stage, we regress insurance coverage (*DOICOV*) on the explanatory variables (including the instrument variable) and estimate the residual values. In the second stage, we regress investment inefficiency on the firm's total D&O coverage limit (*DOICOV*), other control variables, and residual values (*RES*) obtained in the first stage. We use the firm's total D&O coverage limit in the previous year (*LDOICOV*) as the instrumental variable. The results indicate an insignificant *RES*, so the null hypothesis of the Durbin–Wu–Hausman test is not rejected; i.e., *DOICOV* may not be endogenous.

$$OVI_{i,t+1} \text{ or } UNI_{i,t+1} = \beta_0 + \beta_1 DOICOV_{i,t} + \beta_2 INST\_OWN_{it} + \beta_3 DOICOV_{i,t} \cdot INST\_OWN_{it} + \beta_4 Size_{i,t} + \beta_5 Age_{i,t} + \beta_6 TANG_{i,t} + \beta_7 Slack_{i,t} + \text{Year fixed effects} + \text{Industry fixed effects} \quad (4)$$

$$OVI_{i,t+1} \text{ or } UNI_{i,t+1} = \beta_0 + \beta_1 DOICOV_{i,t} + \beta_2 DOMSIN_{it} + \beta_3 DOICOV_{i,t} \cdot Dome\_INSU_{it} + \beta_4 Size_{i,t} + \beta_5 Age_{i,t} + \beta_6 TANG_{i,t} + \beta_7 Slack_{i,t} + \text{Year fixed effects} + \text{Industry fixed effects} \quad (5)$$

where *DS_OWN* is the percentage of the common stock owned by the directors and supervisors of the firm; *INST_OWN* is the percentage of the common stock owned by the institutional investors; *Dome_INSU* takes the value of 1 if the companies purchase D&O insurance from domestic-owner insurers and 0 otherwise.

To alleviate concerns over potential problems arising from the existence of extreme outliers, we winsorize all continuous variables at the top and bottom 1% of the observations. In addition, by construction, the *OVI* (*UNI*) variable is left-truncated (right-truncated) at 0, implying that ordinary least squares (OLS) coefficients would be biased. To avoid this truncation bias, Model 2 to Model 5 are estimated using truncated regression (Maddala, 1983).

4. Empirical results

4.1. Descriptive statistics

Table 1 presents descriptive statistics for investment efficiency, D&O insurance, and other variables used in the study. About 61% (2049 ÷ 3356) of the observations belong to the over-investment group, and the deviations for the normal investment level are 4.8% and 6.6% of the average total assets for the over-investment and under-investment groups, respectively. On the average, companies in Taiwan are likely to suffer from over-investment problems, and the magnitude of investment inefficiency is larger in the over-investment group.

Table 1 also shows that about 54% of sample observations purchased D&O insurance during the sampling period, indicating that the rate of purchasing D&O insurance is lower than that in developed countries (e.g., Chung and Wynn, 2008; Chen et al., 2012). The mean insurance coverage is 154,458 in thousands of New

Table 1
Descriptive statistics.

	Mean	Std. dev.	Percentiles		
			25th	50th	75th
INVEFF	0.004	0.081	−0.024	0.013	0.041
OVI ($N = 2049$)	0.048	0.047	0.017	0.033	0.061
UNI ($N = 1307$)	0.066	0.074	0.015	0.038	0.088
DOI	0.535	0.499	0	1	1
Coverage (in thousands of New Taiwan dollars)	154,458	34,810	0	32,760	164,000
DOICOV	0.043	0.146	0	0.005	0.047
DS_OWN	23.359	14.563	12.770	19.540	30.010
INST_OWN	35.065	22.085	17.160	31.300	50.600
Dome_INSU	0.365	0.481	0.000	0.000	1.000
Size	15.206	1.451	14.225	15.033	15.976
Age	25.732	11.910	17.000	23.000	33.000
TANG	0.305	0.209	0.152	0.288	0.424
Slack	0.195	0.186	0.075	0.145	0.259

All variables are as defined in Appendix A.

Taiwan dollars (about 5 million U.S. dollars). The mean insurance coverage ratio is 4.3% of the average total assets. As for other key variables, the means of the proportion of common stocks owned by directors and institutional investors are 23.36% and 35.07%, respectively. Otherwise, about 37% of the sample observations purchased D&O insurance from domestic insurance companies, suggesting that foreign insurance companies are market leaders of D&O insurance.

Table 2 reports Pearson correlations. As predicted, the proxy for the deviation from the normal investment level is positively correlated with D&O insurance coverage. In addition, the proxy for investment inefficiency is negatively correlated with firm size and asset tangibility. It is positively correlated with financial slackness. In general, the variables are not highly correlated. The largest correlations are between *DS_OWN* and *INST_OWN* ($\rho = 0.426$) and between *Size* and *INST_OWN* ($\rho = 0.420$).

4.2. Results: basic models

Table 3 presents the truncated regression results.[6] We report the coefficient and t-value based on robust standard errors. Our first hypothesis states that D&O insurance is adversely related to investment efficiency. When the dependent variable is *Over-investment* (*OVI*), the coefficient on *DOICOV* is significant and positive at the 1% level (0.103, t-value = 3.16). In contrast, the coefficient on *DOICOV* in the under-investment groups is not significant, suggesting that D&O insurance is more influential in inducing the problem of over-investment. Most control variables demonstrate coefficients with signs and statistical significance consistent with prior studies. A mature firm (*Age*) is less likely to over-invest since it is more difficult to raise additional cash to finance the new investment (Fazzari et al., 1988; Hubbard, 1998). In particular, firms with higher asset tangibility (*TANG*), which mitigates over-investment problems by reducing a firm's debt capacity (Myers and Rajan, 1998), and greater financial slack (*Slack*) are likely to face an over-investment problem (Jensen, 1986). Furthermore, the coefficients on *Size* are also consistent with findings in prior studies (Chen et al., 2011).[7] In brief, the results in Table 3 indicate that D&O insurance policies are influential when a firm makes investment decisions, supporting Hypothesis 1.

4.3. Results: interaction analysis

In this section, we investigate whether the relationship between investment efficiency and D&O insurance varies with director ownership, institutional investors, and the domicile status of insurance companies. Columns 1 and 4 of Table 4 present results for how director ownership affects the association between investment efficiency and D&O insurance coverage. Under the over-investment scenario, after

[6] Some may consider the application of panel data analysis. Nevertheless, the following two reasons explain why it may not feasible in this study. First, Greene (2006) notes that a Hausman test enables researchers to distinguish between the random and fixed effect specifications only under *linear* models (e.g., Hausman, 1978; Wooldridge, 2002). In other words, the truncated regression model (used in our analysis) is one of *non-linear* models, so no suitable statistical test is available for us to conduct for the purpose of choosing between random and fixed effect specifications. Second, a methodological problem occurs if we apply the panel data regression when a truncated dependent variable (Hsiao, 2003; Alan et al., forthcoming) is used. The slopes affected by the *incidental parameter problem* will be biased toward zero while estimating the fixed effect specification for panel data under truncated regression models (Greene, 2004, 2006). The random effect specification still induces the problem that the conditional function of individual specific effects is unknown, although the advantage of the random effect approach is that there is no *incidental parameter problem* (Hsiao, 2007). Even though prior studies have proposed modified models (e.g., Honore, 1992), Hsiao (2007) argues that these approaches impose very severe restrictions on the data and cannot yield consistent estimators in the case of a finite period.

[7] For comparison, Table 3 also includes the intercept terms (e.g., *DS_OWN* and *INST_OWN*) that will be used to interact with our primary variable (*DOICOV*) in Table 4. *DS_OWN* is not significant (t-value = −0.30 for *Over-investment*, and t-value = −0.23 for *Under-investment*). One may assume that director ownership enhances efficiency (i.e., the convergence-of-interest hypothesis), but in fact, it is also more subject to the moral hazard problem (the entrenchment hypothesis). Therefore, the net effect of director ownership may be insignificant because the two forces cancel each other out. As for the coefficient on *INST_Own*, it is not significant (t-value = −1.22) in the *Over-investment* model while it is positively significant (t-value = 2.56) in the *Under-investment* model. Such results are consistent with higher institutional ownership, not necessarily related to the improvement of efficiency, because director ownership may induce excessive managerial conservatism, similar to the findings in some prior studies (Chowdhury and Geringer, 2001; Biddle et al., 2009; Cornett et al., 2007).

Table 2
Correlation matrix.

	1	2	3	4	5	6	7	8
1. *INVEFF*	1.000							
2. *DOICOV*	0.030*	1.000						
3. *DS_OWN*	−0.018	0.038**	1.000					
4. *INST_OWN*	−0.086***	0.032*	0.426***	1.000				
5. *Size*	−0.086***	−0.243***	−0.122***	0.420***	1.000			
6. *Age*	−0.011	−0.148***	−0.034*	−0.010	0.247***	1.000		
7. *TANG*	−0.310***	−0.101***	0.050***	0.088***	0.173***	0.137***	1.000	
8. *Slack*	0.142***	0.123***	−0.030*	0.030*	−0.133***	−0.327***	−0.229***	1.000

All variables are as defined in Appendix A.
*** Indicates significance at the 1% level.
** Indicates significance at the 5% level.
* Indicates significance at the 10% level.

controlling for the effect of director ownership, the *DOICOV* is still significantly and positively associated with over-investment. The main effect of *DS_OWN* is not significant. Specifically, the coefficient of *DOICOV* × *DS_OWN* is negative and significant (coef. = −0.005, t = −3.15), implying that higher director ownership improves the incentive-alignment problem and thus mitigates the over-investment induced by D&O insurance. In contrast, the coefficient for *DOICOV* × *DS_OWN* (coef. = −0.027,

Table 3
Association between D&O insurance and investment efficiency.

	Dependent variable	
	Over-investment (*OVI*)	*Under-investment* (*UVI*)
	(1)	(2)
DOICOV	0.103	0.275
	(3.16)***	(0.59)
DS_OWN	−0.000	−0.001
	(−0.30)	(−0.23)
INST_OWN	−0.000	0.007
	(−1.22)	(2.56)**
Size	−0.009	−0.114
	(−3.37)***	(−2.69)***
Age	−0.002	−0.007
	(−4.44)***	(−1.52)
TANG	−0.068	0.944
	(−3.13)***	(3.28)***
Slack	0.069	0.061
	(4.12)***	(0.27)
Intercept	0.099	−0.217
	(1.65)*	(−0.29)
Year and industry fixed effects	Yes	Yes
Wald statistics	315.70	16.53
N	2049	1307

[a]This table reports the results of the association between D&O insurance and investment efficiency. The primary variables of interest are *DOICOV*, while the control variables are *DS_OWN*, *INST_OWN*, *Size*, *Age*, *TANG*, and *Slack*.
[b]Estimations are based on a truncated regression approach. ***, **, and * indicate significance at the 1, 5, and 10% levels, respectively. T-statistics based on heteroskedasticity-consistent standard errors are presented in parentheses below the coefficients. To control for outliers, all of the continuous variables are winsorized at the top and bottom 1%. Year and industry fixed effects are included but not reported for brevity.
[c]See Appendix A for variable definitions.

Table 4
The conditional effect of director/institutional ownership and the type of insurer on the association between D&O insurance and investment efficiency.

	Dependent variable					
	Over-investment (*OVI*)			*Under-investment* (*UVI*)		
	(1)	(2)	(3)	(4)	(5)	(6)
DOICOV	0.236	0.235	0.120	0.920	1.937	0.563
	(4.11)***	(4.52)***	(2.38)**	(1.11)	(1.81)*	(1.45)
DOICOV × *DS_OWN*	−0.005			−0.027		
	(−3.15)***			(−0.97)		
DOICOV × *INST_OWN*		−0.004			−0.034	
		(−3.68)***			(−1.82)*	
DOICOV × *Dome_INSU*			−0.172			0.162
			(−2.41)**			(0.34)
DS_OWN	0.000	0.000	0.000	0.001	−0.001	−0.001
	(1.08)	(0.20)	(0.25)	(0.28)	(−0.47)	(−0.58)
INST_OWN	−0.000	0.000	−0.000	0.007	0.009	0.004
	(−1.02)	(0.25)	(−1.36)	(2.55)**	(2.74)***	(2.41)**
Dome_INSU			0.004			−0.027
			(0.40)			(−0.49)
Size	−0.008	−0.009	−0.011	−0.110	−0.118	−0.044
	(−3.11)***	(−3.52)***	(−2.92)***	(−2.68)***	(−2.77)***	(−1.83)*
Age	−0.001	−0.001	−0.002	−0.007	−0.007	−0.005
	(−4.43)***	(−4.47)***	(−4.06)***	(−1.52)	(−1.53)	(−1.35)
TANG	−0.069	−0.068	−0.079	0.927	0.917	0.754
	(−3.23)***	(−3.21)***	(−2.57)**	(3.31)***	(3.34)***	(4.13)***
Slack	0.071	0.072	0.054	0.078	0.073	−0.002
	(4.30)***	(4.44)***	(2.50)**	(0.35)	(0.33)	(−0.01)
Intercept	0.089	0.102	0.166	−0.257	−0.178	−1.229
	(1.55)	(1.77)*	(1.57)	(−0.36)	(−0.25)	(−1.84)*
Year fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes
Wald statistics	329.29	334.73	204.78	17.45	17.07	16.42
N	2049	2049	1072	1307	1307	724

[a]This table reports the results of the effect of director/institutional ownership and the type of insurer on the association between D&O insurance and investment efficiency. The primary variables of interest are *DOICOV*, *DOICOV* × *DS_OWN*, *DOICOV* × *DS_INST*, and *DOICOV* × *Dome_INSU*, while the control variables are *DS_OWN*, *INST_OWN*, *Dome_INSU*, *Size*, *Age*, *TANG*, and *Slack*.
[b]Estimations are based on a truncated regression approach. ***, **, and * indicate significance at the 1, 5, and 10% levels, respectively. T-statistics based on heteroskedasticity-consistent standard errors are presented in parentheses. Year and industry fixed effects are included but not reported for brevity.
[c]See Appendix A for variable definitions. Sample sizes in columns 3 and 6 are smaller because only observations that have D&O insurance are applicable when analyzing the effect of insurer type.

t = −0.97) is negative but not significant in the under-investment group.[8] Therefore, we obtain support for Hypothesis 2(a).

Columns 2 and 5 of Table 4 present the results of testing Hypothesis 2(b). As predicted, the results indicate that the adverse effect of D&O insurance on investment efficiency is lower for firms with higher institutional ownership because the monitoring power of institutional investors should be more effective in this case. The coefficient for *DOICOV* × *INST_OWN* is negative and significant (coef. = −0.004, t = −3.68)

[8] Similar to findings in Table 3, *DS_OWN* is not significant, consistent with the undetermined effect of director ownership on investment efficiency. *INST_Own* is positively significant in the *Under-investment* model, implying that higher institutional ownership leads to excessive managerial conservatism, but the association is weakened when the firm purchases D&O insurance because institutional investors may understand the adverse effect of D&O insurance on internal corporate decisions and thus monitor more effectively.

Table 5
D&O insurance and investment efficiency: robustness check.

	Dependent variable							
	Over-investment (*OVI*)				*Under-investment* (*UVI*)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: alternative investment efficiency model with the asset growth variable								
DOICOV	0.109	0.207	0.207	0.092	0.220	1.416	2.796	0.580
	(3.49)***	(3.67)***	(4.07)***	(1.99)**	(0.28)	(1.02)	(1.49)	(1.13)
DOICOV × DS_OWN		-0.004				−0.047		
		(−2.22)**				(−1.12)		
DOICOV × INST_OWN			−0.003				−0.052	
			(−2.70)***				(−1.61)	
DOICOV × Dome_INSU				−0.127				0.147
				(−1.84)*				(0.23)
DS_OWN	−0.000	−0.000	−0.000	−0.000	−0.001	0.002	−0.001	−0.001
	(−1.28)	(−0.08)	(−0.91)	(−0.34)	(−0.13)	(0.42)	(−0.32)	(−0.29)
INST_OWN	−0.000	−0.000	0.000	−0.000	0.009	0.008	0.012	0.004
	(−0.36)	(−0.25)	(0.71)	(−0.93)	(1.68)*	(1.71)*	(1.87)*	(1.87)*
Dome_INSU				0.002				−0.054
				(0.21)				(−0.70)
Size	−0.007	−0.007	−0.008	−0.010	−0.200	−0.185	−0.197	−0.061
	(−2.90)***	(−2.68)***	(−3.02)***	(−2.77)***	(−1.91)*	(−1.98)**	(−2.00)**	(−1.82)*
Age	−0.001	−0.001	−0.001	−0.002	−0.013	−0.012	−0.012	−0.007
	(−4.18)***	(−4.14)***	(−4.19)***	(−4.42)***	(−1.34)	(−1.38)	(−1.38)	(−1.41)
TANG	−0.061	−0.062	−0.062	−0.074	1.762	1.678	1.669	0.968
	(−3.24)***	(−3.36)***	(−3.37)***	(−2.53)**	(2.17)**	(2.29)**	(2.27)**	(3.49)***
Slack	0.059	0.061	0.063	0.048	0.052	0.080	0.070	0.027
	(3.87)***	(4.00)***	(4.10)***	(2.39)**	(0.13)	(0.21)	(0.18)	(0.13)
Year and industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald statistics	363.71	372.26	376.31	225.14	5.82	6.73	6.40	9.79
N		2045		1074		1309		720
Panel B: alternative investment efficiency measure after removing the deciles around the zero residuals								
DOICOV	0.082	0.188	0.190	0.114	0.084	0.299	0.688	0.382
	(3.28)***	(4.29)***	(4.70)***	(2.76)***	(0.50)	(0.95)	(2.20)**	(1.69)*
DOICOV × DS_OWN		−0.004				−0.009		
		(−3.40)***				(−0.83)		
DOICOV × INST_OWN			−0.003				−0.013	
			(−3.95)***				(−2.28)**	
DOICOV × Dome_INSU				−0.152				0.043
				(−2.76)***				(0.16)

DS_OWN	−0.000	0.000	−0.000	−0.000	−0.000	0.000	−0.000	−0.000
	(−0.76)	(0.88)	(−0.14)	(−0.19)	(−0.24)	(0.19)	(−0.41)	(−0.09)
INST_OWN	−0.000	0.000	0.000	−0.000	0.002	0.002	0.003	0.001
	(−0.17)	(0.10)	(1.48)	(−0.84)	(2.86)***	(2.81)***	(3.45)***	(1.44)
Dome_INSU				0.008				−0.011
				(1.09)				(−0.36)
Size	−0.006	−0.005	−0.006	−0.007	−0.041	−0.040	−0.043	−0.019
	(−3.31)***	(−3.02)***	(−3.46)***	(−2.58)***	(−3.63)***	(−3.55)***	(−3.79)***	(−1.42)
Age	−0.001	−0.001	−0.001	−0.001	−0.002	−0.002	−0.001	−0.002
	(−3.77)***	(−3.78)***	(−3.82)***	(−3.57)***	(−1.08)	(−1.07)	(−1.02)	(−1.24)
TANG	−0.006	−0.007	−0.007	−0.013	0.237	0.240	0.236	0.336
	(−0.43)	(−0.49)	(−0.47)	(−0.57)	(3.44)***	(3.52)***	(3.55)***	(4.05)***
Slack	0.045	0.047	0.048	0.035	0.006	0.010	0.012	0.015
	(3.79)***	(3.98)***	(4.17)***	(2.04)**	(0.07)	(0.12)	(0.15)	(0.16)
Year and industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald statistics	425.93	444.39	452.80	308.27	76.93	77.80	78.84	32.73
N		1641		877		1046		590
Panel C: excess D&O insurance coverage								
EXCOV	0.087	0.222	0.217	0.100	−0.006	0.187	0.800	0.039
	(3.44)***	(4.30)***	(4.32)***	(2.87)***	(−0.04)	(0.67)	(0.91)	(0.31)
EXCOV × DS_OWN		−0.005				−0.013		
		(−3.24)***				(−0.64)		
EXCOV × INST_OWN			−0.004				−0.015	
			(−3.31)***				(−0.96)	
EXCOV × Dome_INSU				−0.104				0.598
				(−1.73)*				(1.56)
DS_OWN	−0.000	−0.000	−0.000	0.000	−0.001	−0.002	−0.002	−0.001
	(−0.70)	(−0.37)	(−0.21)	(0.27)	(−0.54)	(−0.60)	(−0.65)	(−0.67)
INST_OWN	−0.000	−0.000	−0.000	−0.000	0.008	0.008	0.008	0.004
	(−1.48)	(−1.32)	(−1.40)	(−1.74)*	(2.62)***	(2.64)***	(2.64)***	(2.49)**
Dome_INSU				−0.008				−0.012
				(−0.96)				(−0.27)
Size	−0.011	−0.010	−0.010	−0.012	−0.143	−0.140	−0.143	−0.073
	(−4.07)***	(−3.92)***	(−3.89)***	(−3.50)***	(−2.84)***	(−2.86)***	(−2.88)***	(−2.74)***
Age	−0.001	−0.001	−0.001	−0.002	−0.005	−0.005	−0.005	−0.004
	(−4.02)***	(−4.07)***	(−4.04)***	(−3.45)***	(−1.09)	(−1.11)	(−1.12)	(−0.97)
TANG	−0.068	−0.067	−0.067	−0.086	0.961	0.949	0.945	0.742
	(−3.20)***	(−3.20)***	(−3.21)***	(−2.74)***	(3.02)***	(3.03)***	(3.06)***	(3.84)***
Slack	0.077	0.079	0.079	0.061	0.047	0.037	0.041	−0.017
	(4.46)***	(4.70)***	(4.69)***	(2.66)***	(0.19)	(0.15)	(0.17)	(−0.10)
Year and industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald statistics	299.17	314.73	318.92	195.84	14.22	14.73	14.63	27.48
N		2009		1045		1264		696

(continued on next page)

Table 5 (*continued*)

	Dependent variable							
	Over-investment (*OVI*)				*Under-investment* (*UVI*)			
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel D: additional control variables								
DOICOV	0.114	0.228	0.231	0.179	0.178	0.686	1.799	
	(3.48)***	(3.95)***	(4.30)***	(3.46)***	(0.39)	(0.85)	(1.84)*	
DOICOV × DS_OWN		−0.004				−0.021		
		(−2.79)***				(−0.82)		
DOICOV × INST_OWN			−0.004				−0.033	
			(−3.24)***				(−1.94)*	
DOICOV × Dome_INSU				−0.199				
				(−2.90)***				
DS_OWN	0.000	0.000	0.000	0.000	−0.000	0.001	−0.001	
	(0.20)	(1.33)	(0.60)	(0.73)	(−0.05)	(0.36)	(−0.33)	
INST_OWN	−0.000	−0.000	0.000	−0.000	0.006	0.006	0.008	
	(−1.18)	(−1.03)	(0.10)	(−1.37)	(2.67)***	(2.64)***	(2.86)***	
Dome_INSU				0.009				
				(0.88)				
Size	−0.007	−0.006	−0.007	−0.007	−0.088	−0.086	−0.094	
	(−2.07)**	(−1.94)*	(−2.29)**	(−1.69)*	(−2.42)**	(−2.41)**	(−2.56)**	
Age	−0.001	−0.001	−0.001	−0.002	−0.007	−0.006	−0.007	
	(−3.69)***	(−3.74)***	(−3.76)***	(−3.03)***	(−1.54)	(−1.52)	(−1.60)	
TANG	−0.073	−0.075	−0.074	−0.090	0.941	0.924	0.927	
	(−3.57)***	(−3.67)***	(−3.65)***	(−3.14)***	(3.56)***	(3.57)***	(3.60)***	
Slack	0.033	0.035	0.036	−0.001	0.187	0.194	0.204	
	(1.88)*	(2.01)**	(2.09)**	(−0.03)	(0.76)	(0.82)	(0.86)	
LEV	−0.085	−0.083	−0.081	−0.110	0.033	0.043	0.089	
	(−4.87)***	(−4.80)***	(−4.69)***	(−4.64)***	(0.15)	(0.20)	(0.42)	
ROA	0.042	0.043	0.050	0.107	−0.381	−0.359	−0.342	
	(1.15)	(1.19)	(1.36)	(2.54)**	(−0.92)	(−0.88)	(−0.85)	
NUMSEAT	0.001	0.001	0.001	0.001	−0.027	−0.026	−0.028	−0.007
	(0.53)	(0.61)	(0.62)	(0.59)	(−1.58)	(−1.56)	(−1.65)*	(−0.61)
INDP	0.035	0.030	0.029	0.035	0.098	0.110	0.055	0.226
	(1.64)	(1.38)	(1.33)	(1.24)	(0.44)	(0.50)	(0.25)	(1.25)
DUAL	0.017	0.015	0.015	0.018	0.074	0.068	0.079	0.012
	(2.94)***	(2.76)***	(2.74)***	(2.52)**	(1.04)	(0.98)	(1.12)	(0.22)
Year and industry fixed effects	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Wald statistics	336.91	348.14	350.71	234.81	19.86	21.03	20.08	17.52
N		2049		1072		1307		724

in the over-investment group. The *DOICOV* measure continues to load positively and significantly. Surprisingly, the coefficient for *DOICOV* × *INST_OWN* is negative and significant (coef. = −0.034, t = −1.82) in the under-investment group, implying that higher institutional ownership might mitigate not only over-investment but also under-investment problems. Therefore, we obtain empirical support for Hypothesis 2(b).

Finally, we consider whether different types of insurance companies will have varying effects on the association between D&O insurance and investment efficiency. The main effect of *DOICOV* continues to be positive and significant in this specification. The results in Column 3 of Table 5 also show that the coefficient on the interaction term is negative and significant (coef. = −0.172, t = −2.41). Under the under-investment scenario, the coefficient on the interaction term is positive but not significant (coef. = 0.162, t = 0.34). Thus, the results, consistent with Hypothesis 3, suggest a pronounced over-investment effect of D&O insurance for firms that buy D&O insurance from foreign insurers, compared with firms that buy from domestic insurers.

4.4. Additional tests

4.4.1. Alternative investment efficiency model specifications

The first set of robustness checks involves conducting alternative estimation models of investment efficiency. First, following McNichols and Stubben (2008), we reexamined the results by replacing revenue growth with asset growth in Model 1. Second, observations around the zero residuals are dropped to mitigate measurement error problems. Following Chen et al. (2011), we divided the observations into groups of deciles based on the positive and negative *Inveff*, respectively. Then, the bottom decile in the over-investment group and the top decile in the under-investment group were removed. We repeated all of the tests using the remaining observations. The results after the first and second adjustments are reported in Panel A and Panel B of Table 5. For instance, the coefficients (statistical significance) of *DOICOV* are 0.109 (t-value = 3.49) and 0.082 (t-value = 3.28) in column 1 of Panel A and Panel B of Table 5. Since the corresponding value before the additional adjustments; i.e., the coefficient (statistical significance) of *DOICOV*, is 0.103 (t-value = 3.16), as reported in column 1 of Table 3, so it appears that our results are robust to the two adjustments.

4.4.2. Alternative measure of D&O insurance coverage

Two-stage regression models are applied to estimate the excess insurance coverage. In the first stage, we regress total insurance coverage on its determinant based on prior studies (e.g., Wynn, 2008) and define *EXCOV* as the difference between actual insurance coverage and predicted coverage. The first-stage model shows the following:

$$DOICOV_{i,t} = \beta_0 + \beta_1 Size_{i,t-1} + \beta_2 \mathrm{LEV_{it}} + \beta_3 AVGROA + \beta_4 STDROA + \beta_5 Slack_{i,t} + \beta_6 MTB_{i,t} + \beta_7 INDP_{i,t} + \beta_8 BLOCK_{i,t} + \text{Year fixed effects} + \text{Industry fixed effects}. \quad (6)$$

Notes to Table 5:

[a]Panel A reports the results of using alternative investment efficiency models. Panel B reports the results after making adjustments specified in Chen et al. (2011). In brief, observations are divided into groups of deciles based on the positive and negative investment inefficiency measure. Then, the bottom decile in the over-investment group and the top decile in the under-investment group were removed. Panel C reports the results of using excess D&O insurance coverage as the dependent variable. Panel D reports the results after additional control variables are included.

[b]The results in each column correspond to equivalent results in Tables 3 and 4. For instance, the robustness check for the result in column 1 of Table 3 is presented in the column 1 of this panel; the robustness check for the result in column 2 of Table 3 is presented in column 5 of this panel. In addition, the robustness check for the result in column 1 of Table 4 is presented in column 2 of this panel.

[c]Estimations are based on a truncated regression approach. ***, **, and * indicate significance at the 1, 5, and 10% levels, respectively. T-statistics based on heteroskedasticity-consistent standard errors are presented in parentheses. Year and industry fixed effects are included but not reported for brevity.

[d]See Appendix A for variable definitions. Sample sizes in columns 4 and 8 are smaller because only cases that have D&O insurance are applicable when analyzing the effect of insurer type.

In the second stage, the excess insurance coverage, *EXCOV*, is used to re-implement all regressions. Panel C of Table 5 reports the results. The coefficient on *EXCOV* is still positive and significant. As for interaction analyses, the coefficients on the interaction terms are negative and significant. Overall, the results in Panel C of Table 5 are similar to those reported in Table 4, indicating that the results are not driven by the choice of proxy for expected legal liabilities.

4.4.3. Additional control variables

Additional corporate and governance characteristic variables are included to check the robustness of results because prior studies argue that the corporate governance mechanism is associated with investment efficiency (e.g., Biddle et al., 2009; Chang et al., 2006; Ferreira and Matos, 2008). As for corporate characteristic variables, *LEV* is the debt ratio, measured by total liabilities to total assets; *ROA* is income before extraordinary items divided by average total assets. As for corporate governance variables, *NUMSEAT* is the total number of board seats; *INDP* is the proportion of independent directors on the board; *DUAL* is equal to 1 if the chairperson of the board of directors serves as CEO and 0 otherwise. The results of this analysis are presented in Panel D of Table 5. Again, the results are not affected by the inclusion of additional control variables.

5. Conclusion

Recent studies suggest that managers behave opportunistically under D&O insurance policies by increasing friction through reducing expected legal liabilities. We extend this stream of research by documenting the association between D&O insurance coverage and investment efficiency. Specifically, we investigate how ownership structure or the type of insurer affects the preceding association.

We test the hypothesis that executives with higher legal liability insurance coverage induce more investment inefficiency based on a sample of Taiwan firms listed on the Taiwan Stock Exchange or the GreTai Securities Market between 2008 and 2010. We find a significant positive association between D&O insurance coverage and over-investment, suggesting that D&O insurance reduces directors' and officers' incentives to act in the best interests of shareholders. We also find this positive association to be attenuated in firms with high percentages of director stock or institutional ownership, consistent with notions that higher director ownership helps align with managers' and shareholders' benefits and higher institutional ownership leads to greater monitoring of management. Finally, we show that the positive association between D&O insurance coverage and over-investment is less pronounced for firms that purchase D&O insurance from local insurers compared with those who purchase from foreign insurers, suggesting that the monitoring effect is prominent for locals.

Our results have potential implications for investors and regulators. Until now, only a few countries have mandated the disclosure of D&O purchase. We demonstrate the adverse effect of D&O insurance policies on the efficiency of internal capital allocation, a conclusion that has been suggested but not directly documented by earlier or concurrent work. This evidence reinforces the notion that D&O insurance policies contain additional information about managers' behavior and should be made mandatory disclosures, which has been constantly argued by earlier studies (Baker and Griffith, 2006; Gupta and Prakash, 2012). Consequently, the release of such D&O information is also beneficial to existing and potential shareholders in making investment decisions.

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Appendix A. Variable definition

Variable name	Definition
Investment efficiency	
INVEFF	We define the residuals from estimating the following model based on Biddle et al. (2009) as investment inefficiency. The model is shown as follows: $INVEST_{t+1} = \alpha_0 + \alpha_1 NEG + \alpha_2 Growth + \alpha_3 NEG \times Growth + \varepsilon$ where *INVEST* is measured as the sum of new purchase of property, plant, and equipment (PPE) and the research and development expenditure less the sale of property, plant, and equipment (PPE) in the following year, scaled by average total assets. *NEG* is a dummy variable that is equal to 1 if the revenue growth ratio is negative in the current year and 0 otherwise. *Growth* is the growth rate of net sales over the previous year.
OVI	Over-investment, positive residues from the investment efficiency estimation model
UNI	Under-investment, the absolute value of negative residues from the investment efficiency estimation model
D&O insurance	
DOI	The dummy variable is equal to 1 if the firm has D&O insurance in the current year and 0 otherwise
Coverage	The firm's total D&O coverage limit in thousands of New Taiwan dollars
DOICOV	The firm's total D&O coverage limit, scaled by average total assets
EXCOV	The excess coverage, defined as the residual from the regression of *DOICOV* on the lagged firm size, standard deviation of return on assets over the past five years (*AVGROA*), average return on assets over the past five years (*STDROA*), leverage (*LEV*), financial slack (*Slack*), market-to-book ratio (*MTB*), the portion of independent directors on the board (*INDP*), the percentage of the common stock owned by blockholders (*BLOCK*), and industry and year fixed effects.
Firm characteristics	
Size	The natural logarithm of total assets
Age	The firm age
TANG	Asset tangibility, measured as the fixed assets to average total assets
Slack	Financial slack, measured as the sum of cash and short-term investment to average total assets
DS_OWN	The percentage of the common stock owned by the directors and supervisors of the firm
INST_OWN	The percentage of the common stock owned by institutional investors
Dome_INSU	The variable is equal to 1 if firms buy D&O insurance from domestic-owned insurers and 0 otherwise
LEV	The total liabilities to total assets, measured at the end of the current year
ROA	The return on assets, defined as income before extraordinary and discontinued scale by average total assets
NUMSEAT	The number of directors and supervisors on the board
INDP	Proportion of independent directors who serve on the board
DUAL	The dummy variable is equal to 1 if the CEO is also the chairperson of the board and 0 otherwise.

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