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Overinvestment, ownership structure, and directors' and officers' liability insurance☆

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ABSTRACT

This study examines the moderator effect of directors' and officers' liability insurance (D&O insurance) on the relationship between ownership structure and overinvestment. We find that firms with D&O insurance and higher insurance coverage have a higher probability of overinvestment. These results show the D&O insurance is like a moral hazard effect. We also find evidence that the relationship between ownership structure and overinvestment is affected by D&O insurance. As well as the results support that the firms purchasing D&O insurance is moderator effect on ownership structure and overinvestment.

1. Introduction

The financial literature points out the potential conflicts of interest between managers, stockholders, and debtholders that give rise to managerial entrenchment and expropriation, as well as self-interest influence in choosing sub-optimal investment projects, e.g. overinvestment (Chen, Sun, & Xu, 2016; Guariglia & Yang, 2016; Jensen & Meckling, 1976; Pindado & de la Torrel, 2009). In other words, managers have incentives to use their firm's free cash flow to undertake negative net present value projects for empire building, entrenchment, or the expropriation of wealth from shareholders that could damage the value of the firm (Jensen & Meckling, 1976; and; Stulz, 1990).

When insider ownership at high levels makes insiders more entrenched and less subject to market discipline (Cho, 1988). Brealey, Myers, and Allen (2019) also claim that high insider ownership may cause the empire building behavior of manger. In addition, Shleifer and Vishny (1989) indicate that the empire building investment approach of mangers leading to overinvestment. Therefore, they argue that the relationship between ownership and overinvestment is positive.

Moreover, an efficient system of corporate governance helps minimize problems regarding suboptimal investment decisions (La Rocca, La Rocca, and Cariola, 2011; Richardson, 2006) and mitigates the dependency of firm investment on internal funding (Hasan, Palani-Rajan Kadapakkam, & Kumar, 2008). Cho (1988) argues that ownership and corporate investment have a negative relationship. Since the firms with better investment opportunities and insider hold a larger fraction of shares, higher insider ownership more closely aligns the interests of managers and shareholders, therefore increasing corporate value to reduce an overinvestment project. Pindado and de la Torrel (2009) also indicate that the convergence of interests between owners and managers proves to be more helpful at

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avoiding overinvestment problems, whereas the monitoring of managers by large shareholders is more useful in firms suffering from overinvestment problems.

In addition to reducing sub-optimal investment through ownership, the literature points out that insurance can helps mitigate sub-optimal managerial behavior and improve corporate governance and firm performance (Mayers & Clifford, 1987; Aunon-Nerin & Paul, 2008). Mayers and Clifford (1987) claim that protecting directors from liability exposure may also improve firm management, since liability exposure induces managers to forego risky positive net present value projects and risk-averse outside directors to abandon entering board (Zou, 2010). The empirical results using China sample find that the use of property insurance is efficient and effective at mitigating agency problems between shareholders and managers (Zou, Wong, Shum, Xiong, & Yan, 2008; and; Jia, Adams, & Buckle, 2011).

One way to improve corporate governance and transfer litigation risk to insurers is through directors' and officers' liability insurance (D&O insurance). Boards of directors and managers are now taking greater responsibility for enhancing business operations, yet are seeing increased litigation risk. D&O insurance thus provides financial protection for directors, officers, and firms if the directors and officers are sued for mismanagement of their firm's operations (Gupta & Prakash, 2012; and Egger, Radulescu, & Rees, 2015). Therefore, directors and mangers commonly employ D&O insurance to shield them from litigation and personal financial liability in North America, Europe, and emerging economies (Jia & Tang, 2016).

In addition, D&O insurer provides a valuable underwriting monitoring service such as knowing the financial position of the firm in relation to potential loss severity, the probability distribution of loss risk and monitoring opportunism behavior of the board of directors. (Holderness, 1990; O'Sullivan, 2002; Core, 2000; and Boyer & Tennyson, 2015). Hence, D&O is a means to protect shareholders by being a substitute for monitoring from financial institutions (Zou et al., 2008; and; Egger et al., 2015). Firms with weaker governance structures will have a stronger demand for D&O insurance, in order to shift monitoring to the insurer (Boyer & Tennyson, 2015; Park, 2018). Yuna, Sun, and Cao (2016) and Jian, Mao, and Yuan (2019) also provide support that D&O insurance appears to improve corporate governance.

However, the findings for the effect of D&O insurance on the managerial behavior in the literature are ambiguous. Other than the monitor effect, the other effect of D&O insurance is moral hazard. With regard to the incentive for purchasing D&O insurance, managers' speculation behavior could increase as a result of purchasing D&O insurance. The empirical results conclude that corporate governance and managerial entrenchment affect the decision to purchase D&O insurance in exploring IPO return, M&A, loan spread, earnings management, and independent directors who behave less responsibly (Core, 1997; Chalemers, Dann, & Harford, 2002; Lin, Officer, & Zou, 2011; Chang & Hsiao, 2012; Lin, Officer, and Zou, 2013; Boyer & Tennyson, 2015; and; Jia & Tang, 2016).

Core (1997) indicates that risk-averse directors and officers require D&O insurance as a condition for their service, and the cost of D&O insurance can be a concern for firms with lower-growth opportunities and large free cash flow. For high-growth firms, the benefit of D&O insurance can outweigh this cost. Hwang and Kim (2013) find a positive relationship between firm risk-taking behavior and D&O insurance, which is more pronounced for companies with higher growth opportunities. Their results imply that D&O insurance benefits firms by mitigating the risk-averse of managers, particular for high-growth firms that can benefit more from such a change in behavior. Previous studies confirm that managerial entrenchment, expropriation, and self-interest induce directors and officers to purchase D&O insurance (Chalemers et al., 2002; Lin et al., 2011; and Hwang & Kim, 2013).

Pindado and de la Torrel (2009) find insider ownership lessens the dependence of investment on internal finance and lower overinvestment. However, Core (1997) find that the function of D&O insurance for supplementing corporate governance. O'Sullivan (1997) and Core (1997) also confirm that insider ownership and D&O insurance can be interpreted as substitute monitoring devices. Boyer and Stern (2012) show that D&O coverage limits are lower under greater insider control. Therefore, we further argue that the association between ownership structure and overinvestment is affected by D&O insurance - namely, D&O insurance is a moderator for the relationship between ownership and overinvestment. If D&O insurance is like a moral hazard effect that intensifies the entrenchment of insiders, then overinvestment increases. Conversely, if D&O insurance is like a monitor effect that mitigates the entrenchment of insiders, then overinvestment decreases.

Using a sample of Taiwan-listed firms from 2008 to 2014 to examine the joint association among ownership, overinvestment, and D&O insurance, we find that firms with D&O insurance and higher insurance coverage have a higher probability of overinvestment. The empirical results confirm that D&O insurance has a moral hazard effect that the behaviors of managerial entrenchment induce directors and officers to purchase D&O insurance.

Given the state of knowledge, our study contributes to the literature in a number of ways. First, Chung and Wynn (2008) point out that the corporate governance implications of D&O insurance vary significantly with the legal regime. Prior studies in D&O insurance focus predominantly on Canada, the U.S., and the U.K., however, Taiwan is a civil law country among emerging markets (Chen & Li, 2010; and; O'Connor & Byrne, 2015). In Taiwan, there is weaker protection for minority shareholders, but the governance practices of listed companies have increased between 2001 and 2002 (O'Connor & Byrne, 2015). In addition, the ownership structure of publicly listed companies in Taiwan is closely tied to controlling shareholders (Claessens, Djankov, Joseph, Fan, & Lang, 2002). Accordingly, we provide different ownership structure and institutional and legal environments evidence to integrate the relationship among D&O insurance, overinvestment, and ownership structure.

Second, our sample has a more balanced mix of insurance users and non-users. This attribute further enables us to conduct a more powerful test of our research hypotheses.

Third and finally, we provide new evidence for the debate of the governance effect of D&O insurance's impact on investment. Our study complements existing studies, which demonstrate that entrenched or poorly governing managers who are protected from shareholder discipline make poor decisions about major corporate investments.

The remainder of this paper is organized as follows. Section 2 presents D&O insurance and the development of corporate

governance in Taiwan. Section 3 discusses the methodology and empirical framework employed in this study. Section 4 offers our empirical analysis and robustness checks. Section 5 provides the conclusions.

2. D&O insurance and the development of corporate governance in Taiwan

The first D&O insurance policy was introduced by AIG and approved by Taiwan in 1996. At that time, many large- and medium-sized firms in Taiwan were raising funds from overseas in order to increase their competitiveness and visibility, which resulted in the expansion of firms' operation risks. D&O insurance mitigates the exposure of firms with unknown risks and is a transferring litigation risk tool for firms. After the Asian financial crisis in 1997, corporate governance was actively introduced in Taiwan. In 2002, the "Corporate Governance Best Practice Principles for TWSE/TPEx Listed Companies" was implemented, and a number of foreign and local insurers began to actively develop and underwrite D&O insurance.

Table 1 lists the number of written premiums, which have been dramatically increasing from 2008 to 2014. We find that the market for D&O insurance has exhibited intense competition due to the increasing number of insurers, resulting in a decline in premiums. Therefore, premiums have not increased year by year. The number and amount of incurred losses and the loss ratio were the highest in 2008. Moreover, the loss ratio was the lowest in 2014.

In addition to the increasing supply of D&O insurance, the demand of firms for it has also increased year by year. Apart from the implementation of "Corporate Governance Best Practice Principles for TWSE/TPEx Listed Companies", the Securities and Futures Investors Protection Center (SFIPC hereafter) was set up in 2003 in Taiwan, causing increasing demand for D&O insurance. SFIPC introduces a group litigation mechanism, which increases the probability of directors being sued and increases the legal risks of the company. Therefore, the demand for D&O insurance increases. In accordance with the Securities and Futures Investor Protection Act, SFIPC protects investors' rights and interests and files class-action litigation services on behalf of investors.

The class-action litigation mechanism in Taiwan is similar to those in the U.S., U.K., Japan, and South Korea. In Taiwan, class-action litigation covers victims of the same fraud case who are allowed to collectively seek protection as exercised by SFIPC. Defendants of class-action litigation in Taiwan, which include heads of companies, directors and supervisors of companies, accountants, underwriters, and financial institutions, can be sued and be ruled liable for engaging in making false statement. As of year-end 2014, the SFIPC has assisted investors in 187 class action suits with claims exceeding NT$43.9 billion and involving 112,000 claimants.

Moreover, the Securities and Futures Investor Protection Act was amended in 2009, allowing investors' ability to file derivative suits, to request the courts to discharge incompetent directors and officers. From the above description, the litigation risk of firms' directors and officers in Taiwan is rising, thus resulting in greater demand for D&O insurance. This phenomenon is the same as found by Core (1997).

3. Sample and data description

3.1. Sample selection

The sample in this study comes from companies listed on the Taiwan Stock Exchange and Taipei Exchange (GreTai Securities Market). Our sample period is between 2008 and 2014. The starting year of 2008 is selected, because this was the year that firms were required to mandatorily disclose on the Market Observation Post System whether they had purchased D&O insurance. The financial and corporate governance data of the sample firms are obtained from Taiwan Economic Journal.

We exclude firms in the financial industry and firms with missing data on financial and corporate governance. This filtering leaves 9,187 firm-year observation and 1,502 firms for the years from 2008 to 2014.

3.2. Data description

We begin by describing the summary statistics of the sample. Table 2 reports the sample distribution by year and by D&O insurance purchases from 2008 to 2014. We find that firms carrying D&O insurance have dramatically increased from 49.04% to 62.36% from

Table 1
The market for D&O insurance in Taiwan. This table shows the premiums, losses, and losses ratio of D&O insurance in Taiwan from 2008 to 2014. Losses ratio = (amount of paid losses + amount of outstanding losses year-end)/amount of earned premiums. The unit of amount of premium and losses is NT$1,000.

Accident Year	Written Premiums		Earned Premiums		Paid Losses	Outstanding Losses Year End	Incurred Losses		Losses Ratio (%)
	Number	Amount	Number	Amount	Amount	Amount	Number	Amount	
2008	972	595,938	923	617,535	119,698	291,220	88	410,919	66.54
2009	1,006	590,939	980	595,475	46,949	8,832	48	55,781	9.37
2010	1,119	626,730	1,066	622,949	70,670	3,254,	42	73,925	11.87
2011	1,278	707,129	1,210	662,105	22,263	40,628	25	62,892	9.50
2012	1,395	679,098	1,339	689,778	33,942	68,664	36	102,607	14.88
2013	1,467	777,972	1,425	727,470	24,265	40,204	49	64,469	8.86
2014	1,521	752,698	1,494	724,063	9,266	11,398	44	20,665	2.85

Data source: Taiwan Insurance Institute

2008 to 2014. As seen from Table 2, half of the listed companies in Taiwan have carried D&O insurance. The average of insurance coverage to total assets (*Ins_ratio*) from 2008 to 2014 is 0.101, which is much smaller than that for Canada, the U.K., and the U.S. (Chung & Wynn, 2008; and Lin et al., 2011). From the insurance coverage of D&O, we found that the litigation risk protection of directors and officers in firms is relatively inadequate in Taiwan compared with Canada, the U.K., and U.S.

We draw firms from twenty industries in our sample, including traditional (Cement, Food, Plastic, Textile), Biotechnology, Electronics, and Cultural and Creative industries. Table 3 shows the sample distribution by industry and by D&O insurance purchase, where industry classification is based on the TEJ industry classification guide. The sample size is 5,060 firm-year observations in the electronics sector, because the majority of listed companies are in this industry in Taiwan. We find that the highest ratio for purchasing D&O insurance is in Electronics at 69.98%. The Agriculture Technology industry has the lowest ratio for purchasing D&O insurance at 0%. The highest average *Ins_ratio* is for Cultural and Creative, and the lowest is for Cement.

3.3. Variables

As for the variables of D&O insurance, we adopt overinvestment, ownership structure, and control variables from Core (1997), Richardson (2006), Pindado and de la Torrel (2009), Farooq, Ahmed, and Saleem (2015), Boyer and Stern (2012), Lin, Officer, Wang, and Zou (2013), Hwang and Kim (2013), and Boyer and Tennyson (2015).

3.3.1. D&O insurance

A firm is defined as purchasing D&O insurance in year *t* if it has a D&O insurance contract in the fiscal year that ends in year *t*. We use two variables as proxy for D&O insurance. First, *Purchase* covers whether a firm has purchased D&O insurance. For this variable, a value of 1 signifies that the companies purchased D&O insurance and a value of 0 means they did not purchase D&O insurance. Second, *Ins_ratio* is calculated by dividing the coverage amount of D&O insurance for a firm by its assets denominated in Taiwan's currency (Lin et al., 2013).

3.3.2. Overinvestment

We first follow Richardson (2006) to calculate the difference between actual and expected investment as follows:

$$\begin{aligned} Investment_{it} = {} & \alpha_0 + \beta_1 \mathrm{Q}_{it-1} + \beta_2 Cashflow_{it-1} + \beta_3 Size_{it-1} + \beta_4 Investment_{it-1} \\ & + Leverage_{it-1} + \mathrm{Return}_{it-1} + Year + Industry + \nu_i + \varepsilon_{it} \end{aligned} \tag{1}$$

Investment represents capital expenditure that is the ratio of the sum of research and development expenditure, capital expenditure, and acquisition expenditure and then deducting cash receipts from the sale of property, plant and equipment to previous year's total assets. *Q* is defined as Tobin's Q, which calculates the sum of market value and the amount of debt to total assets. *Cashflow* is calculated by the sum of net income after tax, depreciation, and amortization to total assets. *Size* is the natural logarithm of total sales. *Leverage* is total liability to total assets, and *Return* is annualized stock return. We control for by including time dummies (*Year*) and industry dummies (*Industry*) to control business cycle effects and industry-specific effect, respectively (Guariglia & Yang, 2016, and Jian et al., 2019).ν_i is a firm fixed effect in Eq. (1). We employ fixed effect Panel data regression to estimate ε_{it} in Eq. (1) as *Invest_res*, which denotes the difference between actual investment ($Investment_{it}$) and expected investment.

In Richardson (2006), *Invest_res* is positive corresponding to overinvestment. Hence, in this study, if the value of *Invest_res* is greater than zero, the value of *Overinvestment* equals *Invest_res*, if the value of *Invest_res* is less than 0, the value of *Overinvestment* is zero.

3.3.3. Ownership structure

Ownership structure affects the likelihood of board opportunism in purchasing insurance and investment decision (Pindado & de la Torrel, 2009; Boyer & Stern, 2012; Boyer & Tennyson, 2015). The variable of ownership structure in our empirical model is the ratio of the board of directors holding firm shares (*Board_share*).

Table 2
Sample by year. The sample comprises 9,187 firm-year observations for firms in the TSE and TPEx between 2008 and 2014. Purchase and Non-purchase are defined as firms purchasing D&O insurance and not purchasing D&O insurance, respectively. *Ins_ratio* is the coverage of D&O insurance to total assets.

Panel A: Number of sample firms								
Year	2008	2009	2010	2011	2012	2013	2014	Total
Non-Purchase	609	588	571	579	557	543	542	3,989
Purchase	586	650	678	728	804	854	898	5,198
Total	1,195	1,238	1,249	1,307	1,361	1,397	1,440	9,187
Panel B: Ratio of sample firms								
Non-Purchase	50.96	47.50	45.72	44.30	40.93	38.87	37.64	43.42
Purchase	49.04	52.50	54.28	55.70	59.07	61.13	62.36	56.58
Panel C: Average coverage of D&O insurance								
Ins_ratio	0.209	0.080	0.074	0.103	0.097	0.075	0.069	0.101

Table 3
Sample by industry. The table shows the sample by industry. N is the number of firms in each industry. Purchase and Non-purchase are defined by the ratio of those firms purchasing D&O insurance and not purchasing D&O insurance, respectively. *Ins_ratio* is the average of *ins_ratio* by each industry.

Industry	N	Non-purchase	Purchase	Ins_ratio
Cement	52	67.31	32.69	0.002
Food	168	60.71	39.29	0.019
Plastic	178	60.67	39.33	0.012
Textile	380	87.63	12.37	0.022
Electrical Machinery	470	60.64	39.36	0.021
Electrical & Cable	107	63.55	36.45	0.006
Chemical & Biotechnology	671	46.94	53.06	0.034
Glass & Ceramic	30	76.67	23.33	0.006
Paper & Pulp	49	71.43	28.57	0.009
Iron & Steel	279	57.71	42.29	0.018
Rubber	76	71.05	28.95	0.004
Automobile	35	80.00	20.00	0.003
Electronics	5,060	30.02	69.98	0.043
Building Material & Construction	485	66.19	33.81	0.020
Shipping &Transportation	153	58.17	41.83	0.004
Tourism	128	65.63	34.38	0.007
Trading & Consumers Goods	154	61.04	38.96	0.002
Cultural & Creative	106	32.08	67.92	0.137
Agriculture Technology	8	100.00	0.00	0.000
Oil, Gas & Electricity	83	74.70	25.30	0.007
Others	507	44.97	55.03	0.070

3.3.4. Control variable

The control variables in this paper are the number of directors on the board, the ratio of institutional investors that hold shares (Stepanov, 2013), free cash flow held by managers (Fu, 2010; Harford, Mansi, and Maxwell. 2008; Kang, Kumar, & Kee, 2006), the ratio of cash dividends (Pindado & de la Torrel, 2009), firm size (Chung & Wynn, 2008; Core, 1997; Hwang & Kim, 2013; Zou et al., 2008), and leverage (Egger, Eadulescu, and Rees, 2015).

Stepanov (2013) indicate that institutional ownership can engage a powerful monitor role on manager to prevent overinvestment. Chen et al. (2016) find that a larger board size mitigates overinvestment. A firm's investment depends on internal cash flow (Jensen & Meckling, 1976; Stulz, 1990). However, according to Chung and Wynn (2008), firms with excess cash are more likely to purchase D&O insurance since it is cheaper than self-insurance. Therefore, we use board size and free cash flow as control variables.

The investment policy of a firm cannot be taken as independent of its dividend policy. Thus, paying out dividends may reduce the inefficiency of marginal investments (La Porta, Lopez-de-Silanes, Shleifer, & Vishny, 2000). As such, we include the ratio of cash dividends into the empirical model.

O'Sullivan (1997) note that as firm size increases so do the costs of external ownership as a monitoring device, and therefore larger firms are more likely to use D&O insurance as a means of monitoring. Larger firms should have higher demand for insurance as they face a higher probability of lawsuits compared to smaller firms (Chung & Wynn, 2008; Core, 1997; Hwang & Kim, 2013; Zou et al., 2008). Leverage is the proxy for financial risk (Egger, Eadulescu, and Rees, 2015). The control variables of the empirical model in this paper thus include firm size and leverage.

3.4. Econometric model

The dependent variable, *overinvest*, is a value greater than 0, and therefore we employ Tobit regression to examine the relationship among overinvestment, ownership structure, and D&O insurance. The empirical model is:

$$Overinvest_{it} = \alpha + \beta_1 Ownership\ Structure_{it} + \beta_2 Ownership\ Strucutre_{it}^2 + \beta_3 D\&O_{it} + +\beta_3 Control\ variables_{it} + Year\ fixed\ effect + Firm\ fixed\ effect + \varepsilon_{it} \quad (2)$$

We define *D&O* as the purchase of D&O insurance. The variable of ownership structure is *Board_share*. The control variables in this paper are the number of board of directors (*Board_size*), *Free cash flow*, *Dividend ratio*, firm size (*Size*), and *Leverage*. *Market* is binary variables; if the firm is TSE, then the value of *Market* equals 1 and otherwise 0.

To explore D&O insurance as the moderator between ownership structure and overinvestment, we use the interaction between *D&O* and ownership structure in the empirical model as follows:

$$Overinvest_{it} = \alpha + \beta_1 Ownership\ Structure_{it} + \beta_2 Ownership\ Strucutre_{it}^2 + \beta_3 (Ownership\ Structure \times D\&O)_{it} + \beta_4 Control\ Varibles_{it} + Year\ fixed\ effect + firm\ fixed\ effect + \varepsilon_{it} \quad (3)$$

4. Empirical results

4.1. Summary statistics

Table 4 presents the summary statistics of all dependent and independent variables. As can be seen from Table 4, the averages of *Overinvestment* with and without D&O insurance are 0.033 and 0.035, respectively. The median value of *Overinvestment* in group without D&O insurance is 0.030. However, the median value of *Overinvestment* in firms with D&O insurance is 0.029. The results show that overinvestment by firms without D&O insurance is higher than firms with D&O insurance. The means of *Board_share* with and without D&O insurance are 22.35 and 24.59, respectively.

Univariate analysis provides the differences in dependent and independent variables used in our model between with and without D&O insurance firms. Table 5 shows the results. The mean and median difference test between the two groups of firms is based on t-statistics and z-statistics, respectively. The comparison results reveal substantial differences in overinvestment (*Overinvest*), ownership structure (*Board_share*), and financial conditions between firms with D&O insurance and those without. We find that firms with D&O insurance show lower overinvestment. The ratio of shares held by block shareholders (*Block_share*) and board of directors (*Board_share*) are both lower in firms with D&O insurance than without D&O insurance. On the contrary, firms with D&O insurance have higher *Tobin's Q, Market Value, Board_size*, *Institution_ratio*, and firm size (*Size*) compared to those not purchasing D&O insurance.

Table 6 shows the correlation coefficient between the dependent and independent variables. We find that the relationship between *Overinvestment* and *Purchase* is significantly negative, but the association between *Overinvestment* and *Ins_ratio* is significantly positive. The results in Table 6 show a significantly positive relation between *Overinvestment* and *Board_share*, the positive association between *Ins_ratio* and *Borad_share*.

4.2. Overinvestment, ownership structure, and D&O insurance

This section describes the results of this study examining how D&O insurance affects the relationship between overinvestment and ownership structure using Tobit regression. The results are shown from Table 7 and Table 8. The proxies for ownership structure in Model (1) of Table 7, *Board_share* and the square of *Board_share*, are negative and positive, respectively. The results are consistent with the literature (Pindado & de la Torrel, 2009; Boyer & Stern, 2012) and confirm that the insider's convergence interest and entrenchment effect. Furthermore, we find that the coefficient on the *Purchase* variable in Model (2) is positive and significant at the 0.05 level, suggesting that firms that purchase D&O insurance tend to overinvest. This empirical evidence supports that D&O insurance induces managerial opportunism, which is consistent with Lin et al. (2013). The result of *Purchase* in Model (3) in Table 7 is also

Table 4
Descriptive statistics. This table presents descriptive statistics for the variables used in our analysis. The sample firms are in the TSE and TPEx between 2008 and 2014. Variable definitions are in Appendix Table.

Variable	Mean	25%	Median	75%	Std.	Min.	Max.
Panel A: Without insurance (N = 3,989)							
Overinvest	0.035	0.017	0.030	0.045	0.038	4.5E-6	1.17
Tobin's Q	1.29	0.89	1.08	1.43	0.85	0.28	28.83
Investment	−0.05	−0.06	−0.031	−0.01	0.15	−7.57	0.81
Invest_res	0.0007	−0.01	0.018	0.03	0.15	−7.24	1.17
Market value	9,385.19	981	2,165	5,514	42,794	40	94,2117
Board_share	24.59	14.10	21.06	31.23	14.31	0.16	94.95
Block_share	22.38	13.73	20.40	28.8	12.07	0	79.81
Institution_ratio	34.71	16.78	31.10	50.69	22.38	0	97.96
Board_size	9.31	8	9	10	2.57	2	32
Free cash flow	0.07	0.03	0.07	0.11	0.09	−1.05	0.94
Dividend_ratio	0.03	0	0.02	0.05	0.05	0	0.77
Size	15.15	14.24	14.99	15.89	1.36	10.39	20.52
Leverage	0.41	0.27	0.41	0.54	0.19	0.01	2.29
Panel B: With insurance (N = 5,198)							
Overinvest	0.033	0.016	0.029	0.046	0.032	0.00003	0.222
Tobin's Q	1.43	0.92	1.15	1.59	0.92	0.25	14.39
Investment	−0.06	−0.07	−0.038	−0.01	0.17	−10.93	0.12
Invest_res	−0.001	−0.01	0.014	0.03	0.07	−2.05	0.22
Ins_ratio	0.06	0.01	0.032	0.07	0.15	0.00001	5.807
Market value	19,229	1,257	3,224	9,065	107,321	31.00	3,656,082
Board_share	22.35	11.66	18.32	29.23	14.75	0	94.56
Block_share	19.22	11.38	17.09	24.46	11.11	0	84.92
Institution_ratio	37.33	18.82	34.32	53.48	22.16	0.01	98.11
Board_size	9.44	8	9	10	1.98	3	20
Free cash flow	0.07	0.03	0.08	0.12	0.12	−4.38	0.73
Dividend_ratio	0.04	0	0.03	0.05	0.04	0	0.65
Size	15.41	14.35	15.20	16.26	1.52	10.36	21.62
Leverage	0.41	0.27	0.41	0.53	0.18	0.01	1.05

Table 5
Univariate analysis. This table presents the results of the difference of variables between with and without D&O insurance using the *t*-test and Z test, where t is the t-value and Z is the Z-value. Variable definitions are in Appendix Table. *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level; and * indicates statistical significance at the 10% level.

	Mean		Median		t	Z
	Without Insurance	With insurance	Without Insurance	With insurance		
Overinvest	0.035	0.033	0.030	0.029	0.001***	0.001
Tobin'sQ	1.29	1.43	1.08	1.15	−0.13***	−0.07***
Investment	−0.05	−0.06	−0.031	−0.038	0.005	0.007***
Invest_res	0.0007	−0.001	0.018	0.014	0.001	0.004***
Market value	9,385.19	19,229	2,165	3,224	−9,844***	−1,059***
Board_share	24.59	22.35	21.06	18.32	2.23***	2.44***
Block_share	22.38	19.22	20.40	17.09	3.16***	2.35***
Institution_ratio	34.71	37.33	31.10	34.32	−2.62***	−3.22***
Board_size	9.31	9.44	9	9	−0.14***	0***
Free Cash flow	0.07	0.07	0.07	0.08	0	−0.01***
Dividend_ratio	0.03	0.04	0.02	0.03	0*	−0.01***
Size	15.15	15.41	14.99	15.20	−0.25***	−0.21***
Leverage	0.41	0.41	0.41	0.41	0.01	0

Table 6
Correlation. This table presents the Pearson correlation coefficients of the variables. Variable definitions are in Appendix Table. *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level; and * indicates statistical significance at the 10% level.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
(1) *Overinvest*	1	−0.02**	0.05***	0.03**	−0.03**	−0.01	−0.09***	−0.16***	0.07***	−0.05***
(2) *Purchase*		1	0.27***	−0.07***	0.02***	0.05***	0.007	0.12***	−0.01	0.01*
(3) *Ins_ratio*			1	0.05***	−0.04***	−0.0008	−0.20***	−0.21***	−0.04***	−0.06***
(4) *Board_share*				1	0.11***	0.11***	0.03***	−0.10***	−0.03***	−0.001
(5) *Board_size*					1	0.18***	0.00	0.23***	−0.02**	0.04***
(6) *Institution_ratio*						1	−0.02	0.17***	0.07***	0.07***
(7) *Free_cash_flow*							1	0.24***	0.20***	0.09***
(8) *Size*								1	0.32***	0.18***
(9) *Leverage*									1	−0.09***
(10) *Dividend_ratio*										1

Table 7
The relationship between purchasing D&O insurance and overinvestment. This table presents the results of the relationship between purchasing D&O insurance and overinvestment using Tobit regression. The dependent variable is overinvestment. Variable definitions are in Appendix Table. *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level; and * indicates statistical significance at the 10% level. The values of t value are in parentheses.

Variable	(1)	(2)	(3)
Intercept	0.10*** (19.17)	0.10*** (19.17)	0.10*** (18.8)
Board_share	−0.0004*** (−3.94)	−0.0004*** (−4.02)	−0.0003*** (−3.08)
Board_share^2	5.7E-06*** (3.74)	5.7E-06*** (3.8)	5.7E-06*** (3.65)
Purchase		0.001* (1.92)	0.001* (1.89)
Purchase Board_share*			−0.0001* (−1.87)
Control variables	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes
N	9,228	9,228	9,228
Log Likelihood	10,547	10,547	10,549

positive and significant.

We further examination the moderator effect of D&O insurance on relationship between ownership structure and overinvestment. However, in Table 7, the coefficient of the interaction between *Purchase* and *Board_share* is negative and significant at 10% level. The result indicates that the influence of *Board_share* on *Overinvest* is affected by changes in purchase D&O insurance, and suggests that the negative effect of ownership structure on overinvestment is weakened for purchasing D&O insurance.

We further employ Tobit regression to examine the association between the coverage of D&O insurance and overinvestment. The results are shown in Table 8. We find that the coefficients of *Board_share* are significantly negative and *Ins_ratio* are significantly positive. The results show that when the firm purchases more D&O insurance, then the probability of overinvestment is higher. We also find that the coefficient of *Ins_ratio** *Board_share* is significantly negative. The result indicates that the influence of *Board_share* on

Table 8
The relationship between insurance coverage and overinvestment. This table presents the results of the relationship between insurance coverage and overinvestment using Tobit regression. Variable definitions are in Appendix Table. *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level; and * indicates statistical significance at the 10% level. The values of t value are in parentheses.

Variable	(1)	(2)
Intercept	0.10*** (18.76)	0.10*** (18.64)
Board_share	−0.0002*** (−3.99)	−0.0004*** (−3.92)
Board_share^2	5.8E-06*** (3.8)	5.7E-06*** (3.77)
Ins_ratio	0.001* (1.84)	0.003* (1.88)
Ins_ratio Board_share*		−0.0001* (−1.98)
Control variable	Yes	Yes
Year fixed effect	Yes	Yes
Firm fixed effect	Yes	Yes
N	5,377	5,377
Log Likelihood Ratio	3,793	3,848

Overinvest is affected by changes in the coverage of D&O insurance.

We find that the coefficients of *Board_share* and the square of *Board_share* in Tables 7 and 8 are the same. The negative relationship between the shares held by the board of directors and the probability of overinvestment is due to the convergent interest of the board of directors and firm value. However, the relationship between the square of shares held by the board of directors and the probability of overinvestment is positive, denoting the effect of entrenchment or expropriation by directors or managers. The coefficients of control variables in Tables 7 and 8 are generally consistent with prior studies (e.g. Pindado & de la Torrel, 2009).

As seen from Tables 7 and 8, our finding suggest that the role of D&O insurance induce managers to overinvestment. In other words, overinvestment of managers' speculation behavior could increase as a result of purchasing D&O insurance. We also consider the moderator effect of D&O insurance that the relation between ownership structure and overinvestment. The interaction term between ownership structure and D&O insurance are significantly negative of Tables 7 and 8, which suggest that the relationship between ownership structure and overinvestment is affected by D&O insurance, as well as the effect of ownership structure on overinvestment is weakened for purchasing D&O insurance and more coverage of D&O insurance. Our finding support that D&O insurance is like a moral hazard effect that intensifies the entrenchment of insiders, then overinvestment increase.

4.3. Robustness test

In Table 9, we further examine how the change in the coverage of D&O insurance impacts the relationship between ownership structure and overinvestment. Here, *Ins_ratio_change* is the difference between *Ins_ratio* in years *t* and *t-1*, which is then divided by *Ins_ratio* in year *t-1*. *Ins_ratio_change_positive* (*negative*) is a dummy variable; when *Ins_ratio_change* is larger or equal (smaller) zero, the value equals 1 and otherwise 0. The results show that the coefficients of *Ins_ratio_change*, and *Ins_ratio_change_positive* are significantly

Table 9
The relationship among ownership structure, overinvestment, and change in D&O insurance. This table shows the results of the relationship among ownership structure, overinvestment, and change in D&O insurance. *Ins_ratio_change* is the difference between *Ins_ratio* in year *t* and *t-1* and then divided by *Ins_ratio* in year *t-1*. *Ins_ratio_change_positive* is a dummy variable; when *Ins_ratio_change* is larger or equal than last year, then the value equals 1 and otherwise 0. *Ins_ratio_change_negative* is a dummy variable; when *Ins_ratio_change* is smaller than last year, then the value equals 1 and otherwise 0. *Rebuy* denotes firms that did not purchase D&O insurance in the previous year, but they purchase this year. *Renobuy* denotes firms that purchased D&O insurance in the previous year, but they did not purchase this year. *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level; and * indicates statistical significance at the 10% level. The values of t value are in parentheses.

Variable	(1)	(2)	(3)	(4)	(5)
Intercept	0.08*** (14.82)	0.09*** (10.92)	0.08*** (14.39)	0.10*** (13.38)	0.10*** (13.14)
Board_share	−0.0004*** (−3.75)	−0.0004** (−2.44)	−0.0004*** (−3.72)	−0.0004*** (−3.12)	−0.004*** (−3.03)
Board_share^2	6.0E-06*** (3.17)	5.5E-06*** (2.09)	6.0E-06*** (3.15)	6.6E-06** (2.95)	6.6E-06*** (2.89)
Ins_ratio_change	0.01* (1.72)				
Ins_ratio_change_positive		0.00001* (1.77)			
Ins_ratio_change_negative			−0.0003*** (−2.65)		
Rebuy				0.004 (1.39)	
Renobuy					−0.01* (−1.81)
Control variable	Yes	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes	Yes
N	4,987	4,099	4,099	4,099	4,099
Likelihood Ratio	5,695	2,805	5,697	5,978	5,979

Table 10
The relationship among overinvestment, block shareholders, and D&O insurance. This table shows the relationship result among overinvestment, the ratio of shares held by block shareholders, D&O insurance, and control variables. *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level; and * indicates statistical significance at the 10% level. The values of t value are in parentheses.

Variable	(1)	(2)	(3)	(4)
Intercept	0.10*** (18.35)	0.10*** (18.09)	0.07*** (12.45)	0.07*** (12.16)
Block_share	−0.0002** (−2.47)	−0.0002** (−1.97)	−0.00009 (−0.86)	−0.0001 (−0.93)
Block_share^2	0.000004** (2.39)	0.000004** (2.32)	0.000001 (0.89)	0.000002 (1.03)
Purchase	−0.001 (−1.14)	0.0003 (0.17)		
*Purchase*Block_share*		−0.000006 (−0.92)		
Ins_ratio			0.01*** (3.21)	0.01*** (2.42)
*Ins_ratio*Block_share*				−0.0008 (−0.71)
Control Variable	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes
N	9,228	9,228	5,198	5,198
Likelihood Ratio	10,542	10,542	6,430	6,430

Table 11
Heckman two-step selection model. This table shows the regression result of the likelihood overinvest on a firm purchase D&O insurance using Heckman two-step selection model. The results of first-step and second-step show on column (1) and column (2), respectively. *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level; and * indicates statistical significance at the 10% level. The values of t value are in parentheses.

	(1)	(2)
Intercept	−1.07*** (−5.25)	0.03** (2.50)
Board_share	−0.02*** (−6.47)	−0.0007*** (−4.10)
Board_share^2	0.0002*** (4.83)	0.000008*** (3.69)
Purchase		0.01*** (3.32)
Employee	0.06*** (4.24)	
Institution ratio	0.002** (2.33)	0.0006** (2.38)
Cash_flow_ratio	−0.59*** (−3.70)	−0.58*** (−9.75)
Dividend_ratio	0.10 (0.30)	−0.009*** (−0.99)
Board_size	−0.01** (−2.34)	−0.0003 (−1.32)
Size	0.07*** (4.25)	−0.001* (−1.96)
Leverage	−0.36*** (−3.72)	0.21*** (−6.82)
Inverse Miller ratio		0.40 (1.52)
Year fixed effect	Yes	Yes
Firm fixed effect	Yes	Yes
N	7,862	7,862
Likelihood ratio	257.54	6,280
Pseudo-R^2	0.03	

Table 12
The relationship among overinvestment, lag ownership structure, and D&O insurance. This table shows that relationship results among overinvestment, the lag variables of ownership structure, D&O insurance, and control variables. *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level; and * indicates statistical significance at the 10% level. The values of t value are in parentheses.

Variable	(1)	(2)	(3)	(4)
Intercept	0.11*** (21.82)	0.11*** (21.54)	0.07*** (13.33)	0.07*** (13.42)
Board_share_lag	−0.004*** (−4.51)	−0.0003*** (−3.70)	−0.0003*** (−3.25)	−0.0003*** (−3.29)
Board_Share^2*_lag*	0.000005*** (4.06)	0.000005*** (3.95)	0.000005** (3.08)	0.000005*** (2.94)
Purchase_lag	0.0008 (0.98)	0.001 (0.70)		
*Pruchase*Board_Share_lag*		−0.00008 (−1.45)		
Ins_ratio_lag			0.009** (2.86)	0.003 (0.73)
*Ins_ratio*Board_share_lag*				0.0001 (1.35)
Control Variable	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes
N	7,046	7,046	3,965	3,965
Likelihood Ratio	10,440	10,441	6,429	6,430

Table 13
The difference in variables between the electronics industry and non-electronics industry. This tables shows the results for the difference of variables between electronics industry and non-electronics industry using the *t*-test and Z test, where t is the t-value and Z is the Z-value. Variable definitions are in Appendix Table. *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level; and * indicates statistical significance at the 10% level.

Variable	Electronics (N = 5,060)		Non-electronics (N = 4,127)		t	Z
	Mean	Median	Mean	Median		
Purchase	0.7	1	0.39	0	−32.53***	−30.97***
Ins_ratio	0.04	0.01	0.003	0	−4.53***	−28.69***
Investment	−0.06	−0.03	−0.06	−0.03	0.44	3.47***
Inves_res	−0.001	0.01	0.001	0.018	0.89	4.80***
Tobin's Q	1.35	1.12	1.4	1.12	2.94***	1.83*
Overinvest	0.018	0.009	0.019	0.007	1.53	1.02
Market value	16.60	14.70	16.40	14.93	−1.79*	6.50***
Board_share	21.53	17.75	25.52	21.93	13.05***	14.29***
Block_share	18.70	17.00	22.89	20.59	17.2***	16.77***
Board_size	9.22	9	9.59	9	7.46***	1.41*
Institution_ratio	33.75	30.37	39.19	36.47	11.65***	11.81***
Free cash flow	0.07	0.07	0.07	0.06	−3.16***	−6.29***
Dividend_ratio	0.04	0.02	0.03	0.021	−8.57***	−5.71***
Leverage	0.39	0.38	0.43	0.43	9.93***	9.94***
Size	15.05	14.85	14.89	14.86	−6.65***	−2.20***

Table 14
The relationship among overinvestment, ownership structure, and D&O insurance in the electronics industry. This table presents the results of the relationship among overinvestment, board of directors' shareholdings, and D&O insurance using Tobit regression in the electronics industry. Variable definitions are in Appendix Table. *** indicates statistical significance at the 1% level; ** indicates statistical significance at the 5% level; and * indicates statistical significance at the 10% level. The values of t value are in parentheses.

Variable	(1)	(2)	(3)	(4)
Intercept	0.09*** (15.77)	0.09*** (15.33)	0.09*** (14.97)	0.09*** (14.85)
Board_share^2	−0.0006*** (−5.39)	−0.0005** (−4.11)	−0.0006*** (−5.25)	−0.0005*** (−5.14)
Board_share	0.000008*** (4.52)	0.000007*** (4.22)	0.000007*** (4.38)	0.000007*** (4.37)
Purchase	0.0007 (0.72)	0.0005 (0.3)		
*Purchase*Board_share*		−0.00005 (−0.78)		
Ins_ratio			0.005 (1.05)	0.008 (1.12)
*Ins_ratio*Board_share*				−0.0001 (−0.56)
Control Variable	Yes	Yes	Yes	Yes
Year fixed effect	Yes	Yes	Yes	Yes
Firm fixed effect	Yes	Yes	Yes	Yes
N	5,060	5,060	3,541	3,541
Likelihood Ratio	6,351	6,351	6,313	6,313

positive, and the coefficients of *Ins_ratio_change_negative* is significantly negative, indicating that the change in coverage of D&O insurance affect overinvestment. The findings indicate that when the firms purchase more coverage of D&O insurance in year t, they will overinvest. When the firms purchase less coverage of D&O insurance in year t, they will decrease overinvest.

We now examine the change in behavior of purchasing D&O insurance. *Rebuy* denotes firms that did not purchase D&O insurance in year *t-1*, but they purchased it in year *t*. *Renobuy* is for firms that purchased D&O insurance in year *t-1*, but they did not purchase it in year *t*. We find the coefficients of *Renobuy* is significantly negative. This means that firms that do not purchase D&O insurance will see decreased risk. It further means that firms adjust their D&O insurance policy according to whether they face any risk.

We also use *Block_share* to proxy for ownership structure. *Block_share* is the ratio of outstanding shares held by block shareholders. We find that the coefficients of *Ins_ratio* in Model (3) and Model (4) is significantly positive on Table 10. The results show that D&O insurance induce the behavior of overinvestment for directors' and officers'.

4.4. Endogeneity

The empirical test of Table 7 is also subject to the concern that a D&O insurance purchase may be non-random and this may cause a self-selection bias. We employ Heckman two-step sample selection model to control for self-selection bias as an alternative approach to mitigate the endogeneity concern. We run a Probit regression of the D&O insurance dummy variable (*Purchase*) on variable for the demand of D&O insurance (Core, 1997, and Boyer & Tennyson, 2015) and we add instrument variable, the number of employee, in regression. We also include year and firm dummies to capture time invariant and firm-specific differences. Results of the first-step regression are reported in column (1) of Table 11. The results in column (1) of Table 11 are consistent that O'Sullivan (2002), Core (1997), Boyer and Stern (2012), and Boyer and Tennyson (2015) display that inside ownership impact the demand for D&O insurance.

As seen from Table 11, in two-step regression, the coefficient of *Purchase* in column (2) using Tobit regression is also significantly

positive as same Table 7. The value of Inverse Miller ratio in Table 11 is 0.40 and insignificant, this implies that the unobserved factors that motivate firms to purchase D&O insurance are insignificant statistically to overinvestment.

We consider that *Board_share* and D&O insurance may be affected by *Overinvestment.* As well as to mitigate endogeneity, Elango and Pope (2008) and Jian et al. (2019) regress the dependent variables in year *t* on the values of independent variables in year *t-1*. Therefore, we regress overinvestment measure in year *t* on the values of ownership structure and D&O insurance and other control variables in year *t-1* to correct for potential endogeneity. The results are shown in Table 12. We find that the sign of the coefficients in *Purchase_lag* and *Ins_ratio_lag* are the same as Tables 7 and 8.

4.5. D&O insurance, ownership structure, and overinvestment in the electronics industry

From the results of Table 3, half of the sample belongs to the electronics industry. As seen from Table 13, the characteristics between electronics and non-electronics are quite different. Sheu and Yang (2005) also find that the U-shaped relationship between productivity and executive-to-insider holding ration in electronics companies in Taiwan. Therefore, we use the subsample of electronics to conduct an empirical analysis of the joint relationship among overinvestment, ownership structure, and D&O insurance. The results are shown Table 14. We find that the signs of coefficients, *Purchase* and *Ins_ratio*, are the same for the entire sample. However, the coefficients of *Purchase* and *Ins_ratio* are both non-significant. It indicates that D&O insurance do not affect overinvestment in the electronics industry.

5. Conclusion

This study analyzes the relationship between ownership structure and corporate investment as affected by firms buying or not buying D&O insurance. In the literature, the effect of D&O insurance is rather ambiguous on the manager's behavior. Hence, we use data from 2008 to 2014 on Taiwan-listed firms to examine the association among ownership structure, D&O insurance, and overinvestment.

Our finding highlight a moral hazard of D&O insurance for overinvestment in risk-taking of managers. We also find that firms with D&O insurance and higher insurance coverage have a higher probability of overinvestment. We find evidence that the relationship between ownership structure and overinvestment is affected by D&O insurance. In our sample, half of the sample belongs to the electronics industry. However, the characteristics between electronics and non-electronics are quite different. In addition, we use the subsample of electronics industry to explore the relationship among overinvestment, ownership structure, and D&O insurance. However, D&O insurance do not affect overinvestment in electronics industry.

These results show the D&O insurance is like a moral hazard effect that intensifies the entrenchment of insiders, then overinvestment increase. As well as the results support that the firms purchasing D&O insurance is moderator effect on ownership structure and overinvestment.

Appendix

Variable definitions.

Variable	Definition
Panel A: Investment	
Investment	(R&D expenditure + capital expenditure + acquisition expenditure - cash receipts from sale of property, plant, and equipment)/total assets
Invest_res	Estimation from eq. (1)
Tobin's Q	The sum of the market value of equity and book value of debt scaled by total assets
Overinvestment	If the value of *Invest_res* is greater than zero, the value of *Overinvestment* equal *Invest_res*, if the value of *Invest_res* is less than 0, the value of *Overinvestment* is zero
Panel B: D&O insurance	
Purchase	A dummy variable equal to 1 if the firm purchases D&O insurance and otherwise 0
Ins_ ratio	Coverage of D&O insurance/total assets
Panel C: Corporate governance	
Block_share	Major shareholders holding more than 5% of shares/outstanding shares
Board_size	Natural logarithm of the number of board directors
Institution_ratio	Shares of institutional investors/outstanding shares
Board_share	Shares of the board of directors/outstanding shares
Panel D: Control Variable	
Cash_flow_ ratio	(After-tax profit + depreciation-tax-interest expense - cash dividends)/total assets
Dividend ratio	Cash dividends/total assets
Size	Natural logarithm of total sales in the fiscal year
Leverage	Total debt/total assets
Market	A dummy variable equal to 1 if the firm is listed on TSE and otherwise zero

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