

Cash Holdings and Cash Flow Uncertainty

Lin Cho-Min¹, Chien I-Hsin², Chan Min-Lee³ and Chen Hui-Wen⁴

Abstract

In light of increasing global financial market volatilities, firms are encountering a more uncertain cash flow than ever. To avoid missing investment opportunities, firms will hold cash as a precautionary measure. We investigate whether cash holdings in Taiwanese firms is indeed driven by the uncertainty of cash flow. Our empirical results confirm that uncertainty of cash flow is the most important factor that explains why firms hold cash. In addition, we found that the influence of cash flow uncertainty in cash holdings is asymmetric between better and poorer earnings sampled firms; that is, firms hold more (less) cash when their cash flows are more volatile at relatively better (poorer) earnings. Moreover, we verify that above results are not affected by a firm's financial constraints or quality of corporate governance. Our contribution is to provide the first observation that cash-flow volatility plays the key role in explaining a firm's cash holding. Our study is particularly meaningful for countries such as Taiwan that has smaller firms and highly uncertain business operations originating from increasingly global financial market turbulence and political disturbances. Our empirical results could serve as a useful reference for countries with shallow-plate markets, such as those in South East Asia.

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Keywords: Cash holdings, Cash flow uncertainty, Corporate governance

1 Introduction

There is increasing evidence that in recent decades, corporations have begun to hold more cash. Amess, Banerji and Lampousis (2015) believe that increasing cash holdings have become a global phenomenon. From the 1990s to the 2000s, cash holdings represented 10% of US gross domestic product (GDP) (Dittmar and Mahrt-Smith, 2007), and US firms' cash holdings increased annually by an average of 0.46% from 1980 to 2006 (Bates, Kahle and

¹Professor, Finance department, Providence University, Taiwan.

²Associate professor, Accounting department, Providence University, Taiwan, correspondent author

³Professor, Finance department, Providence University, Taiwan.

⁴Graduate student, Finance department, Providence University, Taiwan.

Stulz, 2009). Corporate cash holdings in Japan and South Korea are 44% and 34% of their GDPs, respectively. In addition, Europe, Mainland China, and Taiwan show the trend of increasing cash holdings (Ferreira and Vilela, 2004; Chen, Chen, Schipper, Xu, and Xue, 2012; Kuan, Li, and Liu, 2012). Kuan et al. (2012) note that the average level of cash holdings in Taiwan listed firms has exceeded that in most developed countries.

One interesting question is the following: Why do corporations hold more internal cash given its lower rate of return? As we know, holding cash generates opportunity costs; conversely, a firm may lose a potential investment opportunity when there is no cash available to make investments, resulting in underinvestment problems. Based on the above, there should be an optimal level of cash holdings⁵. Thus, it appears that holding cash should strengthen the efficiency of cash and enhance firm value when firms hold an appropriate level of cash; therefore, an optimal level of cash does exist⁶. As noted above, current studies have documented the increasing trend of cash holdings since 2000 (Bates, et al., 2009; Juan and Yurdagul, 2013). Bates et al. (2009) indicate that increasing cash holdings primarily originate from a precautionary motive in which firms view cash as a cushion against cash flow uncertainty or cash flow shock⁷. Opler, Pinkowitz, Stulz, and Williamson (1999) note that firms with high growth and high risks of investment earnings hold more cash; Bates et al. (2009) similarly find that firms with high risks hold more cash⁸. Juan et al. (2013) also discover the uncertainty (risks) to be one of the factors affecting firm's cash holdings. Current studies have found that firms with relatively high risk will hold more cash based on either precautionary motives or lower transaction-cost motives. The literature has not discussed the key determinant that influences a firm's cash holdings. Our first purpose is to investigate whether uncertainty is the key factor affecting a firm's cash holdings.

Almeida, Campello, and Weisbach (2004) argue that firms will increase cash holdings when they have greater cash flows (earnings); in other words, cash holding has a positive response to cash flow. This phenomenon is known as the positive cash-flow sensitivity of cash. However, Riddick and Whited (2009) found a negative cash-flow sensitivity of cash. Regardless of the positive or negative cash-flow sensitivity of cash, both Almeida et al. (2004) and Riddick and Whited (2009) imply a linear relationship between cash flow and cash holdings. Instead of linearity between cash flow and cash holdings, Bao, Chan, and Zhang (2012) believe that a non-linear relationship exists. They argue that the response of cash holdings to cash flow depends upon whether firms have positive or negative earnings. Bao et al. (2012) empirically found the asymmetry of the cash-flow sensitivity of cash; that is, the cash-flow sensitivity of cash has different results for positive versus negative earnings. Accordingly, we examine whether the impact of cash flow uncertainty on cash holdings has an asymmetric effect between firms with positive and negative earnings. Thus far, the literature has not discussed the asymmetry of corporate cash holdings on a firm's

⁵Alternatively, holding cash can prevent the high costs of raising capital attributable to financing or paying back debts (Acharya, Almeida, and Campello, 2007).

⁶The trade-off theory holds that an optimal level of cash exists when the marginal benefits and marginal costs of cash are equal; however, the pecking order theory (Myers and Majluf, 1984) does not support the existence of an optimal level of cash.

⁷Most studies support various motives for cash holdings, including the transaction motive, the precautionary motive, the tax motive and the agency motive.

⁸Bates et al. (2009) found that firms that do not pay dividends, newly listed firms and firms that encounter higher risks hold more cash.

risks (volatility); this is the second purpose of our study. Our empirical results are the first to make this observation and should make a major contribution to this topic.

Because of its small market size and high speculation, Taiwan has a shallow financial market. Given those characteristics, Taiwan's financial market is easily influenced by market risks and becomes volatile when encountering the increasing turbulence of political environments and global financial markets. Therefore, it is particularly meaningful to use Taiwan listed firms in examining how cash flow uncertainty affects corporate cash holdings because this approach not only clarifies the role of cash flow uncertainty in cash holdings but also aids in understanding whether cash flow uncertainty is the key factor in explaining the increasing cash holdings of Taiwan listed firms. Our empirical results should provide useful references for corporate cash policy in other shallow financial markets such as those in South East Asia.

2 Literature Review and Hypothesis Development

In general, companies must decide how much earnings should be retained to finance future investments and how much earnings should be used to reward shareholders (via cash dividends, for example). Most of the existing literature regarding cash holdings focuses on factors that affect cash holdings, among which precautionary motives and agency problems of managers' misuse of cash are the most frequently discussed topics (Amess et al., 2015). Accordingly, this paper examines these two theories.

In addition to avoid missing good investment opportunities, a major motive for a company to hold cash is to set aside cash to reduce the impact of financial losses in times of high risk (Damodaran, 2005). From the perspective of risk, both the idiosyncratic volatility that a company faces and the systemic risk of the overall economy can increase the uncertainty in a company's cash flow (risk increase)⁹. Regarding the overall economy, in addition to facing profit decline caused by industrial cycles, a company also suffers from increased profit uncertainty because of economic downturns, which increases the company's revenue uncertainty, including cash flow or earnings uncertainty caused by a poor economic environment or economic impacts (cash flow uncertainty)¹⁰.

Bates et al. (2009) conducted an empirical study regarding the factors that impacted the cash holdings of 13,599 companies in the United States between 1980 and 2006. Based on the level of companies' cash flow uncertainty, Bates et al. (2009) divided the sample

⁹The factors that cause companies to hold increasingly more cash are nothing more than firm-specific characteristics or macroeconomic conditions. However, most of the literature regarding cash holdings focuses on firms' specific characteristics but barely discusses the impact of macroeconomic conditions. Abushammala and Sulaiman (2014) are the first to systematically study the impact of macroeconomic variables in the Middle East and Jordan on corporate cash holdings. The results indicate that gross domestic product, government deficit budget, cash surpluses and credit spreads all have a positive impact on cash holdings.

¹⁰From the perspective of macroeconomic conditions, the global economic downturn and businesses' pessimism about the future provide no incentive to increase investments; therefore, companies are holding more cash. Similarly, in recessions, investors increase the risk premiums of their investments; therefore, companies' external financing costs increase, leading to increased external financing restrictions. In short, economic downturns lead to increased external financing costs, which tempts companies to hold more cash.

companies' industries into five industry categories (quintiles) and found that companies with higher cash flow uncertainty have higher average cash ratios. Moreover, they also noted that the most important motive to influence cash holdings is the "precautionary motive". They argued that companies are facing increasingly many risks; consequently, companies are either unable or unwilling to hedge, thus, firms increasingly hold more cash to prevent crises or defaults due to financial crises. In addition, Brown and Kapadia (2007) indicated that new listed companies have a higher idiosyncratic risk of stock returns and Bates et al. (2009) found that newly listed companies hold more cash. Moreover, as mentioned earlier, Opler et al. (1999) and Juan et al. (2013) noted that earnings uncertainty (risk) is one of the factors that affect a company's cash holdings. When a company faces more uncertainty, it relies more on cash flow. This paper discusses the relationship between cash flow volatility and cash holdings focusing on the countries, such as Taiwan, with thin markets and high vulnerability to external influences (economic or political interference). In addition to facing their own idiosyncratic volatility due to their operations and industry characteristics, companies in these countries also face high uncertainty caused by the global financial market (economy), thus exacerbating the uncertainty in companies' cash flow (earnings). Accordingly, this paper develops the following first hypothesis:

H1: Uncertainty in cash flow (earnings) positively affects a company's cash holdings (supports the precautionary motive) and is the most important factor that affects a company's cash holdings.

Most literature (Bates et al., 2009; Juan et al., 2013) confirms that when a business (or industry) faces increased risk, the company increases cash holdings (positive regression coefficient), which supports the precautionary motive. Empirical results from Bao et al. (2012) indicate that corporate cash holdings exhibit an asymmetric sensitivity to cash flows. Put otherwise, a company's cash holdings have different sensitivities to cash flows when the company's earnings are positive and negative.

In addition to discovering a negative relationship between a company's cash holdings and cash flow, Bao et al. (2012) further divided a company's earnings into positive earnings (earnings greater than 0) and negative earnings (earnings less than 0). They found that when a company has positive earnings, the company will invest more cash in investment proposals with expected positive return because of the positive financial return generated from the previous investment, which reduces its cash holdings, whereas companies with negative earnings will be reluctant to invest more because the previous investment did not generate a positive return; they will thus retain more cash. Nevertheless, from the perspective of behavioral finance, when a company has positive earnings, its manager's risk attitude will shift to be more risk-averse (more conservative), thus reducing investment and holding more cash.

In reference to the study of Bao et al. (2012), we argue that cash flow uncertainty would positively affect a company's cash holdings (support a precautionary motive), in addition, we further divides a company's earnings into positive and negative earnings samples. This paper claims that when a company has positive earnings, the impact of cash flow uncertainty mainly from increases in positive earnings (cash flow) fluctuations on cash holdings would decrease. Put otherwise, a company would decrease cash holdings (increase investment) if its previous investment generated positive financial return

Based on the above-mentioned results, this paper develops the following additional hypotheses:

H2a: For companies with good earnings, the positive impact of cash flow uncertainty on cash holdings is weakened.

H2.1a: For companies with good earnings, the positive impact of cash flow uncertainty on cash holdings becomes greater (from the perspective of behavioral finance).

On the other hand, when a company has negative earnings and when a company's cash flow uncertainty increases, the company will increase cash holdings (reduce investment). Because the company's previous investment generated negative financial return, the increase in cash flow uncertainty is mostly due to an increase in negative or low cash flow (earnings) fluctuations. For the same reason, from the perspective of behavioral finance, when a company has negative earnings, its manager's risk attitude will become more risk-inclined (more risk-taking), thus leading to increased investment and less retained cash.

H2b: For companies with poor earnings, the positive impact of cash flow uncertainty on cash holdings becomes greater.

H2.1b: For companies with poor earnings, the positive impact of cash flow uncertainty on cash holdings decreases (from the perspective of behavioral finance).

Additional Test

This paper focuses on testing two motives (hypotheses) regarding cash holdings: the precautionary motive and the agency problem motive. The precautionary motive hypotheses are primarily examined as above in H1 and H2. Agency problem is discussed below. It has been noted that holding an excessive amount of cash can lead to an increase in the opportunity cost of cash because the deposit rate is less than the profit rate of an investment. Moreover, holding excessive cash can lead to higher agency costs. However, holding much less cash can result in underinvestment (or missing suitable investment opportunities). Therefore, effective corporate governance can reduce agency problems and ensure that companies hold the most appropriate cash amount (Harford, Mansi, and Maxwell, 2008). This paper examines how corporate governance affects a company's cash holdings. On the one hand, holding excessive cash will generate opportunity cost; on the other hand, from the perspective of corporate governance, a company's managers may abuse funds in the pursuit of their personal self-interest, potentially reducing firm value and harming the interests of shareholders (investors) (Jensen, 1986, free cash-flow hypothesis). In other words, excessive cash may encourage managers to misuse cash for their own interests (for example, by making investments with negative NPV), thus leading to agency problems between managers and shareholders (Jensen and Meckling, 1976; Jensen, 1986). In contrast, companies with strong corporate governance have lower agency costs and use the company's cash more efficiently, thus increase shareholder (company) value. In another word, if a company's governance is good enough, it should not generate excessively high agency costs even company holds a great deal cash since the board with full monitoring function should be able to monitor managers¹¹. In contrast, for companies with poor corporate governance (high agency costs), excessive cash will produce high agency costs. From the perspective of financing constraints, strong (poor) corporate governance generally

¹¹From the perspective of free cash flow, effective corporate governance can reduce the agency problems caused by free cash flow by decreasing companies' cash holdings.

indicates less serious (serious) problem of asymmetrical information; thus, external financial constraints are relatively low (high) and external financial costs are low (high), meaning that a company does not need (needs) to hold excessive cash. A study of multinational companies conducted by Dittmar, Mahrt-Smith, and Servaes (2003) found that companies with poor corporate governance (high agency costs) hold more cash¹². In addition, Dittmar and Mahrt-Smith (2007) and Harford et al. (2008) found that although entrenched managers are more likely to accumulate excess cash balances, they also spend excess cash quickly; therefore, they hold minimal cash.

Using sample of Taiwanese listed companies, Kuan et al. (2012) adopted quantile regression to explore how the corporate governance affects the cash level at companies with high and low cash flow. The empirical results indicate that if companies with low cash flow have strong corporate governance in terms of less excess control rights, they would hold more cash (consistent with trade-off theory and pecking order theory); in contrast, if companies with high cash flow have strong corporate governance in terms of less excess control rights, they would hold less cash (consistent with the free cash agency theory). Nevertheless, when studying American companies, Bates et al. (2009) note that agency problems cannot provide a significant explanation why companies increasingly hold more cash. In summary, there is no consensus in the literature about the impact of corporate governance on cash holdings.

Attempting to emphasize the importance of corporate governance, Amess et al. (2015) developed a trade-off model in which a company with financial constraints will hold cash for possible investments while more cash holdings might give manager incentives to misuse of cash. Han and Qiu (2007) revealed that companies with financial constraints hold more cash when cash flow uncertainty increases, yet, companies without financial constraints do not hold much cash when cash flow uncertainty increases. In light of the importance of corporate governance on cash holdings by past literature, this paper starts from base model (Equation 2) to further explore the impact of both corporate governance and financing constraints on cash holdings. In other words, this study is designed to re-examine hypotheses 1 and 2 by categorizing samples according to the quality of corporate governance and the level of financing constraints, thus clarifying the role of corporate governance in cash holdings. Following Kuan et al. (2012), this research also attempt to understand whether companies with high and low cash holdings respond differently to cash flow uncertainty.

3 Empirical Model and Variable Definitions

This research uses annual data on Taiwanese firms listed in TSE (Taiwan Security Exchange) during the period from 1990 to 2015. The missing value and certain regulated industries such as the financial industry and the public utility are excluded; ultimately, there are 4,266 firm-year observations in this study. The data source is the Taiwan Economic Journal (TEJ). We formulate the empirical models from Equations (1) to (4) by referring to

¹²Dittmar and Mahrt-Smith (2007) and Pinkowitz, Stulz, and Williamson (2006) found that for companies with greater agency problems, the value of the cash that they hold is lower. Moreover, Lee and Powell (2011) revealed that the value of cash decreases when companies either hold more cash or hold cash for a longer time.

Bates et al. (2009), Kuan et al. (2009), Bao et al. (2012) and Harford et al. (2008). Each equation has been estimated, with the dependent variable defined as cash holdings (CH), change in cash holdings (ΔCH) and extreme cash holdings (EXCH)¹³. In accordance with Petersen (2009) and Gow, Ormazabal, and Taylor (2010), two-way cluster-robust standard errors are adopted in Equations (1) and (2), and the related variable definitions are shown in Appendix 1. We also winsorized data at the extreme top 1% and bottom 1%. The empirical models are shown as follows.

$$\Delta CH_{it} = \alpha_0 + \alpha_1 \Delta CH_{it-1} + \alpha_2 CFV_{it} + \sum_{j=1}^8 \delta_j Z_{jit} + \mu_{it} \quad (1)$$

$$\Delta CH_{it} = \beta_0 + \beta_1 \Delta CH_{it-1} + \beta_2 CF_{it} + \beta_3 CFV_{it} + \beta_4 NEG_{it} + \beta_5 CFV_{it} * NEG_{it} + \sum_{j=1}^8 \delta_j Z_{jit} + \varepsilon_{it} \quad (2)$$

The definitions of all the variables in the equations are defined in the Appendix. The suffixes *i* and *t* of each variable indicate firm and year, respectively; *j* is the number of control variables, and *Z* is the control variable.

To examine Hypothesis 1, we first estimate Equation (1) and then estimate Equation (2). If the cash flow uncertainty in Equation (1) is significantly positive and remains significantly positive, Hypothesis 1 is empirically confirmed, meaning that cash flow uncertainty is the most important factor influencing corporate cash holdings. Regarding Hypothesis 2 (poor earnings), H2b will be empirically supported if β_5 is significantly positive in Equation (2). Conversely, H2.1b is empirically supported if β_5 is significantly negative in Equation (2). Regarding Hypothesis 2 (better earnings) (H2a and H2.1a), we rerun Equation (2) by replacing negative earnings (NEG) with POS as the firms with better earnings.

4 Empirical Results

4.1 Descriptive Statistics

Table 1 is the summary of the statistics for all variables. The mean value (13.91) of cash holdings (CH) is greater than its median (11.54), implying that although most of the firms hold less cash, some hold a large amount of cash. The mean value (8.69) of cash flow (CF) is also greater than its median (8.16), implying that most of the firms have relatively low earnings (cash flow) during the research period. The mean value (10.83) of cash flow uncertainty (CFV) is also greater than its median (10.08), suggesting that the earnings volatilities of certain firms are relatively large. Corporate governance (CG-INDEX) in Taiwan is generally not sufficiently suitable, with a mean of 2.45 and a median of 2.00 (positive skew). The standard deviation of the proportion of independent directors (IND_CG) is greater than its mean value (standard deviation is 0.45; mean is 0.29, and median is 0.00), implying there is a large deviation in IND_CG among firms: in other words, some firms have a high number of independent directors, whereas others have a low number of independent directors. However, this large deviation will improve with the regulation of the minimum number of independent directors when a firm is publicly listed.

¹³According to Kuan et al. (2012) and Kuan, T. H., Li, C.S., and Chu, S.H. (2011), the cash holdings of Taiwanese listed firms are skewed to the right, and quantile regression analysis is appropriately adopted.

Table 1: Descriptive statistics

Variable	obs	mean	sd	min	25%	50%	75%	max
CH	4740	13.91	10.32	0.48	6.04	11.54	18.99	50.87
LNch_non	4740	2.46	1.03	-0.73	1.86	2.57	3.15	4.64
CF	4740	8.69	7.06	-11.91	4.54	8.16	12.48	31.08
CFV2	4740	10.83	4.70	3.07	7.40	10.08	13.60	25.23
CFV4	4740	3.81	4.07	0.30	1.49	2.64	4.60	28.72
CFV10	4740	1.69	0.61	0.80	1.31	1.51	2.13	4.30
CG_INDEX	4740	2.45	0.82	0.00	2.00	2.00	3.00	4.00
IND_CG	4740	0.29	0.45	0.00	0.00	0.00	1.00	1.00
SIZE	4740	16.13	1.40	11.66	15.15	15.94	16.90	21.62
MB	4740	1.47	1.14	0.16	0.83	1.18	1.75	16.71
RD_SELL	4740	15.86	39.21	-92.76	6.56	11.08	17.22	1456.27
NWC	4740	9.68	16.17	-63.91	-0.92	8.65	19.91	70.75
D	4740	0.73	0.44	0.00	0.00	1.00	1.00	1.00
CE	4740	4.01	4.51	0.00	0.95	2.65	5.52	83.10
LEV	4740	42.68	16.86	1.14	30.29	43.68	54.51	98.05
RATTING	4740	5.24	1.53	1.00	4.00	5.00	6.00	9.00

Note: Obs is the number of observations in this study, Mean is the mean value, SD is the standard deviation, Min is the minimum value, Max is the maximum value, Q1 is the top 25th percentile, Median (Q50) is the median value, Q3 is the bottom 25th percentile, CH is the ratio of cash and cash equivalents to total assets (definition 2), LNch_non is the logarithm of CH (definition 1), CF is the cash flow defined as EBITDA/total assets, CFV2 is cash flow uncertainty based on the standard deviation of monthly stock returns over the past two years (definition 1), CFV4 is cash flow uncertainty based on the standard deviation of EBITDA over the past four years (definition 2), CFV10 is cash flow uncertainty based on the standard deviation of industry average earnings over the past ten years (definition 3); CG_INDEX is the corporate governance index considering CEO duality, board size, managerial shareholdings, blockholders' shareholdings and IND_CG), SIZE is firm size, MB is firm's growth, RD_SELL is the ratio of research and development (R&D) expenditures to total sales, NWC is the ratio of net operation cash (total operation cash minus cash) to total assets, D is the dummy of cash dividends (if a firm issues a cash dividend, D is 1, otherwise D is 0), CE is the ratio of capital expenditures (sum of fixed assets and depreciation) to total assets, LEV is the ratio of total debt to total assets, and RATTING is credit ratings. The definition of CG_INDEX is based on Chen et al. (2007); IND_CG is a dummy variable that equals 1 when firms have independent directors.

4.2 Bivariate analysis

As shown in Table 2, we conduct a bivariate analysis of firms' cash holdings in terms of various variables such as earnings, cash flow (CF), cash flow uncertainty (CFV) and other control variables. Panel A shows the mean and median values of the p values of CF0 for

both the T test and the Wilcoxon test. The mean values for CF0 are 13.4199 and 13.9494, respectively, with a p-value of 0.3996, whereas the median values for CF0 are 10.1400 and 11.6200, respectively, with a p-value of 0.0323; this implies that firms with positive earnings hold less cash than those with negative earnings. However, this finding has significance only under the 5% level in the Wilcoxon test. Panel B indicates that the p values of CF50 for both the T test and the Wilcoxon test are 0.0000 and 0.0000, respectively, implying that firms with better earnings hold less cash than firms with poorer earnings. Panel C shows that the p values of CFV2 for both T test and Wilcoxon test are 0.0874 and 0.4442, respectively, suggesting that firms with less cash flow uncertainty hold less cash than firms with higher cash flow uncertainty; however, this has significance only under the 10% level in the T test. Panel D conducts a similar test as Panel C but uses a different measure of cash flow uncertainty, CFV4, and obtains different findings. The results show that the p values of CFV4 for both the T test and the Wilcoxon test are 0.0004 and 0.0010, respectively, suggesting that firms with less cash flow uncertainty hold more cash than firms with higher cash flow uncertainty. Panel E shows that cash holdings are significantly different between high- and low-growth firms; that is, high-growth firms hold more cash than low-growth firms. Panel F provides evidence that large firms hold significantly less cash than small firms. Panel G indicates that there is a significant difference in cash holdings between firms with strong credit ratings and firms with poor credit ratings; that is, firms with a poor rating hold significantly less cash than firms with a strong rating.

Table 2: Bivariate analysis

Panel A: subsample based on earnings equal to zero					
Variable		CF0=0	CF0=1	Difference	P-value
CH	Mean	13.9494	13.4199	0.5295	0.3996 T test
	Median	11.6200	10.1400	1.4800	0.0323** Wilcoxon test
Panel B: subsample based on median of earnings					
Variable		CF50=0	CF50=1	Difference	P-value
CH	Mean	15.6864	12.1361	3.5503	0.0000*** T test
	Median	13.6900	9.6800	4.0100	0.0000*** Wilcoxon test
Panel C: subsample based on cash flow uncertainty over the previous two years					
Variable		D_CfV2=0	D_CfV2=1	Difference	P-value
CH	Mean	14.0248	13.7955	0.2293	0.0874* T test
	Median	11.7000	11.4000	0.3000	0.4442 Wilcoxon test
Panel D: subsample based on cash flow uncertainty over the previous four years					
Variable		D_CfV4=0	D_CfV4=1	Difference	P-value
CH	Mean	13.3835	14.4375	-1.0540	0.0004*** T test
CH	Median	11.1000	12.1750	-1.0750	0.0010*** Wilcoxon test
Panel E: subsample based on firm growth					
Variable		D_MB=0	D_MB=1	Difference	P-value
CH	Mean	12.7750	15.0498	-2.2748	0.0000*** T test
	Median	10.5450	12.5050	-1.9600	0.0000*** Wilcoxon test
Panel F: subsample based on firm size					
Variable		D_SIZE=0	D_SIZE=1	Difference	P-value
CH	Mean	14.6637	13.1503	1.5134	0.0000*** T test
	Median	12.2900	11.0000	1.2900	0.0000*** Wilcoxon test
Panel G: subsample based on firm credit rating					
Variable		D_RATTING=0	D_RATTING=1	Difference	P-value
CH	Mean	16.6553	12.5303	4.1250	0.0000*** T test
	Median	14.7400	10.1550	4.5850	0.0000*** Wilcoxon test

Note 1: CF0 is 1 for firms with positive earnings if earnings are greater than zero, otherwise 0; CF50 is 1 for firms with better earnings if earnings are above the median, otherwise 0; D_CfV2 is 1 for firms with unstable cash flow if cash flow uncertainty CFV2 is greater than its previous 2-year median, otherwise 0; D_CfV4 is 1 for firms with unstable cash flow if cash flow uncertainty CFV4 is greater than its previous 4-year median, otherwise 0; D_MB is 1 for firms with high growth if MB is greater than its median, otherwise 0;

D_SIZE is 1 for large firms if SIZE is greater than its median, otherwise 0; D_RATTING is 1 for firms with a poor credit rating if RATTING is greater than its median, otherwise 0; Difference is the variable difference of two groups based on the above definitions.

Note 2: The T test is the parametric tests of mean values; the Wilcoxon test is the nonparametric tests of median values.

4.3 Empirical results

Table 3 shows the change in cash holdings results. Model 1 does not consider control variables; Model 2 does consider control variables, and Model 3 considers everything in Model 2, plus year and industry dummies. All three models indicate that cash flow uncertainty (CFV2) has a significantly positive influence on the change in cash holdings (ΔCH_t) meaning that firms with more volatile cash flow hold more cash than those with less volatile cash flow, confirming Hypothesis 1. Moreover, the change in cash holdings in the current period (ΔCH_t) is negatively correlated with the lagged one period of ΔCH_t (ΔCH_{t-1}), implying that the current change in cash holdings will be increased if the change in cash holdings in the previous period is less. The lagged one-period cash holdings (CH_{t-1}) have a significantly negative impact on the change in cash holdings (ΔCH_t), suggesting that the current change in cash holdings will be higher when firms hold less cash in the previous period. Cash flow has a significantly positive impact on the change in cash holdings, suggesting that firms with high cash flows (earnings) will hold more cash. Cash flow uncertainty (CFV2) has a significantly positive correlation with the change in cash holdings; that is, firms will hold more cash when firms' cash flows are highly volatile.

Other control variables have negative impacts on the change in cash holdings, including firm size, firm growth, net working capital, capital expenditures, debt ratio and credit rating, whereas cash dividend has a positive influence on the change in cash holdings. However, this influence is insignificant.

Table 3: Cash flow volatility on change in cash holdings (without interaction terms)

ΔCH_t	Model 1	Model 2	Model 3
Cons	-0.2047 (0.6000)	9.7645*** (0.0000)	12.8623*** (0.0000)
ΔCH_{t1}	-0.1381*** (0.0000)	-0.1368*** (0.0000)	-0.1149*** (0.0000)
CH_{t1}	-0.1093*** (0.0000)	-0.1496*** (0.0000)	-0.1950*** (0.0000)
CF	0.1076*** (0.0000)	0.1493*** (0.0000)	0.1342*** (0.0000)
CFV2	0.1229*** (0.0000)	0.1324*** (0.0000)	0.0670*** (0.0000)
SIZE		-0.2603** (0.0470)	-0.3700*** (0.0060)
MB		-0.3181*** (0.0090)	-0.1876* (0.0700)
RD_SELL		0.0049*** (0.0000)	0.0037** (0.0490)
NWC		-0.0850*** (0.0000)	-0.1000*** (0.0000)
D		0.0481 (0.8740)	-0.0397 (0.8950)
CE		-0.2616*** (0.0000)	-0.2623*** (0.0000)
LEV		-0.0414*** (0.0000)	-0.0535*** (0.0000)
RATTING		-0.3275* (0.0600)	-0.3748** (0.0310)
Obs	4266	4266	4266
YEAR	NO	NO	YES
INDUS	NO	NO	YES

Note: ΔCH_t is the change in cash holdings in the current period; CH_{t1} is lagged one period of CH; ΔCH_{t1} is the change in current cash holdings and lagged-one-period cash holdings; Obs is the number of observations; YEAR is a dummy variable for year; INDUS is a dummy variable for industry; and other variable definitions can be referenced in Appendix 1.

For Hypothesis 2, Table 4 examines the impacts of cash flow volatilities on the change in cash holdings for various measures of corporate earnings from Models 1 to 4. In general, firms hold more (less) cash when they have better (poor) earnings, except in Models 3 and 4. Examining results with positive earnings measured by CFPOS0CFV2, CFPOS10CFV2, CFPOS30CFV2 and CFPOS50CFV2, cash flow volatilities have significantly positive influences on the change in cash holdings at firms with strong earnings, suggesting that firms with strong earnings will hold more cash because they have high cash flow volatility. For those firms with poor earnings measured by CFNEG0CFV2 and CFNEG10CFV2, cash flow volatility has a significantly negative impact on the change in cash holdings, implying that firms with negative earnings will hold less cash when their cash flow is unstable. Except for the results of earnings measured by CFNEG30CFV2 and CFNEG50CFV2, most empirical results conclude that cash flow volatilities on different measures of earnings have different influences on the change in cash holdings, confirming Hypothesis 2.1a/b. The significantly negative relationship between the change in current cash holdings (ΔCH_t) and the change in cash holdings lagged one period (ΔCH_{t-1}) suggests that current cash holdings will be increased if the change in cash holdings in the previous period is lower. The negative relationship between the lagged-one-period cash holdings (CH_{t-1}) and the change in cash holdings (ΔCH_t) represents that current cash holdings will be greater if firms hold less cash in the previous year.

Table 4: The cash flow volatility on the change in cash holdings (with interaction terms in Equation 2 and without considering control variables)

ΔCHt	Model 1	Model 2	Model 3	Model 4
Cons	0.9227** (0.0160)	0.9214** (0.0160)	0.8676** (0.0180)	0.8265** (0.0250)
ΔCHt1	-0.1350*** (0.0000)	-0.1349*** (0.0000)	-0.1360*** (0.0000)	-0.1350*** (0.0000)
CHt1	-0.1156*** (0.0000)	-0.1157*** (0.0000)	-0.1145*** (0.0000)	-0.1127*** (0.0000)
CFV2	-0.0191 (0.6490)	-0.0176 (0.6680)	0.0289 (0.3580)	0.0508* (0.0870)
$\text{CFNEG0CFV2}(\beta_5)$	-0.0150** (0.0110)			
$\text{CFPOS0CFV2}(\beta_5)$	0.0140*** (0.0000)			
$\text{CFNEG10CFV2}(\beta_5)$		-0.0149*** (0.0080)		
$\text{CFPOS10CFV2}(\beta_5)$		0.0139*** (0.0000)		
$\text{CFNEG30CFV2}(\beta_5)$			-0.0059 (0.1680)	
$\text{CFPOS30CFV2}(\beta_5)$			0.0109*** (0.0000)	
$\text{CFNEG50CFV2}(\beta_5)$				0.0004 (0.9010)
$\text{CFPOS50CFV2}(\beta_5)$				0.0097*** (0.0000)
Obs	4266	4266	4266	4266
YEAR	NO	NO	NO	NO
INDUS	NO	NO	NO	NO

Note: CFV2 is the cash flow volatilities measured by the standard deviation of monthly stock returns over the past two years; CFNEG0CFV2 is the interaction between CFV2 and the dummy variable of negative earnings; CFNEG10CFV2 (or CFNEG30CFV2 or CFNEG50CFV2) is the interaction between CFV2 and the dummy variables of the low 10th percentile (or low 30th percentile or low 50th percentile) earnings; CFPOS0CFV2 is the interaction between CFV2 and the dummy variable of positive earnings; CFPOS10CFV2 (or CFPOS30CFV2 or CFPOS50CFV2) is the interaction between CFV2 and the dummy variables of the top 10th percentile (or top 30th percentile or top 50th percentile) earnings; other variables are the same definitions as in Table 2.

Table 5 shows results similar to those of Table 4 but additionally considers control variables, the dummy variable of industry and the dummy variable of year. The results indicate that cash flow volatility has a significantly positive impact on the change in cash holdings when a firm has superior earnings, suggesting that unstable cash flow volatility will push firms to hold more cash when they have better earnings. Furthermore, when negative earnings are measured by zero earnings (CFNEG0CFV2) and the bottom 10th percentile (CFNEG10CFV2), cash flow volatility has a significantly negative influence on the change

in cash holdings when a firm has poor earnings; this suggests that firms with poor earnings will hold less cash. Except for the results of CFNEG30CFV2 and CFNEG50CFV2, the results generally suggest that cash flow volatilities for better and worse earnings have different impacts on the change in cash holdings, confirming behavioral finance Hypotheses 2.1a and 2.1b; this indicates that a manager is risk averse in a firm with superior performance and risk taking in a firm with inferior performance.

The significantly negative relationship between the change in current cash holdings (ΔCH_t) and the change in cash holdings lagged one period (ΔCH_{t-1}) shows that current cash holdings will be increased if the change in cash holdings in the previous period decreases. The negative relationship between the lagged-one-period cash holdings (CH_{t-1}) and the change in cash holdings (ΔCH_t) represents that current cash holdings will be greater if firms hold less cash in the previous year.

Control variables such as firm size, firm growth, net working capital, capital expenditure, debt and credit rating have a negative impact on the change in cash holdings, whereas R&D has a significantly positive effect on the change in cash holdings. Cash dividend payout has a positive effect on the change in cash holdings, but this is not significant, suggesting that cash holdings will not be affected by a cash dividend.

Greater (less) financial constraints mean that firms have more difficulty (less difficulty) raising capital from capital markets or banks. Thus, firms would hold more cash when it is not easier to raise funds. In light of this finding, we further examine the effect of cash flow volatilities on cash holdings in terms of financial constraints. We use different proxies to measure financial constraints, including cash dividend payout, firm growth, firm size and credit ratings. Table 6¹⁴ provides the results of the effect of cash flow volatilities on the change in cash holdings in terms of different measures of financial constraints. Most of the results in Table 6 support findings similar to the cases that do not consider financial constraints, except for CFNEG50CFV2 in Model 2. The above results show that the effect of cash flow volatilities on change in cash holdings will not depend upon whether firms do or do not have financial constraints; this implies the importance of cash flow volatility to cash holdings.

¹⁴ Because of space limitations, we only report the interaction results.

Table 5: Cash flow volatility for the change in cash holdings (with interaction terms in equation (2) and with considering control variables)

	Model 1	Model 2	Model 3	Model 4
Cons	13.8789*** (0.0000)	13.8119*** (0.0000)	13.8488*** (0.0000)	14.1768*** (0.0000)
ΔCH_{it}	-0.1135*** (0.0010)	-0.1135*** (0.0010)	-0.1140*** (0.0010)	-0.1122*** (0.0010)
CH_{it}	-0.1969*** (0.0000)	-0.1968*** (0.0000)	-0.1971*** (0.0000)	-0.1972*** (0.0000)
CFV2	-0.0890** (0.0240)	-0.0868** (0.0250)	-0.0444 (0.1290)	-0.0178 (0.5220)
CFNEG0CFV2 (β_5)	-0.0121* (0.0730)			
CFPOS0CFV2 (β_5)	0.0159*** (0.0000)			
CFNEG10CFV2(β_5)		-0.0118* (0.0700)		
CFPOS10CFV2(β_5)		0.0158*** (0.0000)		
CFNEG30CFV2(β_5)			-0.0037 (0.4390)	
CFPOS30CFV2(β_5)			0.0128*** (0.0000)	
CFNEG50CFV2(β_5)				0.0024 (0.4890)
CFPOS50CFV2(β_5)				0.0113*** (0.0000)
SIZE	-0.3514*** (0.0070)	-0.3485*** (0.0070)	-0.3475*** (0.0070)	-0.3627*** (0.0050)
MB	-0.2397* (0.0630)	-0.2358* (0.0640)	-0.2023* (0.0910)	-0.1855 (0.1120)
RD_SELL	0.0031 (0.1110)	0.0032 (0.1070)	0.0028 (0.1240)	0.0029* (0.0980)

Table 5: Cash flow volatility for the change in cash holdings (with interaction terms in equation (2) and with considering control variables) (continued)

	Model 1	Model 2	Model 3	Model 4
NWC	-0.0985*** (0.0000)	-0.0984*** (0.0000)	-0.0991*** (0.0000)	-0.0996*** (0.0000)
D	-0.0505 (0.8560)	-0.0526 (0.8500)	-0.0779 (0.7830)	-0.0468 (0.8700)
CE	-0.2653*** (0.0000)	-0.2650*** (0.0000)	-0.2642*** (0.0000)	-0.2626*** (0.0000)
LEV	-0.0517*** (0.0000)	-0.0518*** (0.0000)	-0.0544*** (0.0000)	-0.0541*** (0.0000)
RATING	-0.3826** (0.0220)	-0.3802** (0.0230)	-0.3714** (0.0240)	-0.4005** (0.0170)
Obs	4266	4266	4266	4266
YEAR	YES	YES	YES	YES
INDUS	YES	YES	YES	YES

Note: cash flow volatilities (CFV2) and the interactions of CFV2 and various earnings measures are the same as those defined in Table 4; other control variables are the same as those defined in Table 3.

Table 6: Cash flow volatility on the change in cash holdings considering financial constraints (interaction variable only)

	With or without a cash dividend	High- and low-growth firms	Large and small firm size	High and low credit rating
Positive vs. negative earnings	Model 1	Model 2	Model 3	Model 4
CFNEG0CFV2	-0.0189*** (0.0040)	-0.0243 (0.1160)	-0.0104** (0.0330)	0.0131 (0.5040)
CFNEG0CFV2	-0.0138[0.1080]	-0.0041[0.4740]	-0.0118[0.1490]	-0.0140**[0.0380]
CFPOS0CFV2	0.0142*** (0.0000)	0.0151*** (0.0020)	0.0142*** (0.0000)	0.0093* (0.0860)
CFPOS0CFV2	0.0196*** [0.0000]	0.0167*** [0.0000]	0.0166*** [0.0000]	0.0176*** [0.0000]
<hr/>				
10 th percentile earnings				
CFNEG10CFV2	-0.0182*** (0.0040)	-0.0239 (0.1660)	-0.0100** (0.0330)	0.0133 (0.4980)
CFNEG10CFV2	-0.0135[0.1010]	-0.0039[0.4890]	-0.0117[0.1420]	-0.0136**[0.0350]
CFPOS10CFV2	0.0141*** (0.0000)	0.0150*** (0.0020)	0.0140*** (0.0000)	0.0093* (0.0850)
CFPOS10CFV2	0.0193*** [0.0000]	0.0165*** [0.0000]	0.0165*** [0.0000]	0.0174*** [0.0000]

Table 6: Cash flow volatility on the change in cash holdings considering financial constraints (interaction variable only)(continued)

	With or without a cash dividend	High- and low-growth firms	Large and small firm size	High and low credit rating
30 th percentile earnings	Model 1	Model 2	Model 3	Model 4
CFNEG30CFV2	-0.0062*(0.0550)	-0.0116 (0.3130)	-0.0022 (0.3610)	0.0105 (0.2170)
CFNEG30CFV2	-0.0043[0.4870]	0.0012[0.7740]	-0.0036[0.5550]	-0.0046[0.3480]
CFPOS30CFV2	0.0116*** (0.0000)	0.0115*** (0.0010)	0.0116*** (0.0000)	0.0095** (0.0270)
CFPOS30CFV2	0.0147***[0.0000]	0.0140***[0.0000]	0.0133***[0.0000]	0.0137***[0.0000]
50 th percentile earnings				
CFNEG50CFV2	0.0059*(0.0850)	-0.0033(0.5940)	0.0025(0.4320)	0.0067(0.3780)
CFNEG50CFV2	-0.0007[0.8850]	0.0060*[0.0930]	0.0028[0.5670]	0.0016[0.6920]
CFPOS50CFV2	0.0109*** (0.0000)	0.0094*** (0.0010)	0.0107*** (0.0000)	0.0091** (0.0270)
CFPOS50CFV2	0.0143***[0.0000]	0.0126***[0.0000]	0.0133***[0.0000]	0.0120***[0.0000]
Obs	4266	4266	4266	4266
YEAR	YES	YES	YES	YES
INDUS	YES	YES	YES	YES

Note 1: All variables are defined as those in Table 5.

Note 2: Parentheses () represents p values for the results of the without-financial-constraint sample, which includes firms with a cash dividend (Panel A), high-growth firms (Panel B), large firms (Panel C), and strong credit rating firms (Panel D). Brackets [] represents p values for the results of the with-financial-constraint sample, which consists of firms without a cash dividend (Panel A), low-growth firms (Panel B), small firms (Panel C) and poor credit rating firms (Panel D).

Firms hold less cash when they have better corporate governance and lower external capital costs. In view of this finding, we further examine whether the impact of cash flow volatility on cash holdings depends upon corporate governance. We use both the corporate governance index and the ratio of independent directors as proxies of corporate governance. As shown in Table 7, our empirical results reveal similar findings as those that do not consider corporate governance, except for the positive coefficient of CFNEG50CFV2 in Model 1 regardless of strong or poor earnings. The above results indicate that the effect of cash flow volatilities on the change in cash holdings will not depend upon whether firms have strong or weak corporate governance. Again, the importance of cash flow volatility is strengthened for cash holdings.

Table 7: Cash flow volatility on the change in cash holdings considering corporate governance (interaction variable only)

	Corporate governance index	Ratio of independent directors
Positive vs. negative earnings	Model 1	Model 2
CFNEG0CFV2	-0.0148** (0.0410)	-0.0149* (0.0880)
CFNEG0CFV2	0.0081 [0.2400]	-0.0117 [0.1090]
CFPOS0CFV2	0.0165*** (0.0000)	0.0141*** (0.0000)
CFPOS0CFV2	0.0121* [0.0510]	0.0163*** [0.0000]
10 th percentile earnings		
CFNEG10CFV2	-0.0145** (0.0380)	-0.0145* (0.0940)
CFNEG10CFV2	0.0077 [0.2730]	-0.0114 [0.1080]
CFPOS10CFV2	0.0163*** (0.0000)	0.0139*** (0.0000)
CFPOS10CFV2	0.0122** [0.0440]	0.0162**** [0.0000]
30 th percentile earnings		
CFNEG30CFV2	-0.0052 (0.3250)	-0.0039 (0.4170)
CFNEG30CFV2	0.0078* [0.0940]	-0.0036 [0.5200]
CFPOS30CFV2	0.0130*** (0.0000)	0.0114*** (0.0000)
CFPOS30CFV2	0.0121*** [0.0090]	0.0130*** [0.0000]
50 th percentile earnings		
CFNEG50CFV2	0.0008 (0.8440)	0.0046 (0.4570)
CFNEG50CFV2	0.0147*** [0.0000]	0.0019 [0.6040]
CFPOS50CFV2	0.0114*** (0.0000)	0.0104*** (0.0000)
CFPOS50CFV2	0.0101*** [0.0100]	0.0114*** [0.0000]
Obs	4266	4266
YEAR	YES	YES
INDUS	YES	YES

Note 1: All variables are defined as in Table 5.

Note 2: Parentheses () represent the p values for the results with the strong corporate governance sample in which firms have a high value of 3 or 4 in the governance index (Model 1) and a high ratio of independent directors (Model 2). Brackets [] represent p values for the results for the poor corporate governance sample in which firms have a low value of 0, 1 or 2 in the governance index (Panel A) and a low ratio of independent directors (Panel B).

5 Conclusions

The extant literature (Bates et al., 2009; Juan and Yurdagul, 2013) notes that firms hold more cash than ever before. For example, in 2006 Exxon Mobil and Microsoft held more than \$30 billion US in cash (Bates et al., 2009). In addition to the opportunity costs of holding cash, managers at firms with poor governance will squander cash that should be preserved for future investments. The above situations will decrease firm value (particularly for firms with relatively high financial constraints) and harm the interests of shareholders; that is, they will create the agency problem of holding cash. Why, then, would firms hold more cash? One potential reason for high cash holdings is higher cash flow (earnings) volatility given increasing uncertainty. Firms hold more cash for precautionary reasons, to avoid missing favorable investments. Although the literature has discussed cash flow volatility, it considers such volatility a control variable in cash holdings. In view of the increasing volatility in cash flow, this study is the first to conduct an in-depth exploration of whether cash flow volatility is the most important factor in cash holdings from the perspective of cash flow volatility.

Moreover, we argue that the impact of cash flow volatility in cash holdings is non-monotonic; that is, we believe this impact should have an asymmetric effect between positive and negative earnings. Accordingly, we refer to the “asymmetric cash-flow sensitivity of cash holdings” in Bao et al. (2012) and divide the sample into firms with better versus worse earnings to further examine whether there is a symmetric effect between positive and negative earnings in the relation of cash flow volatility in cash holdings. Bao et al. (2012) confirmed the asymmetric sensitivity of cash holding to cash flow volatility; however, the issue of the asymmetric sensitivity of cash holdings to “cash flow volatility” has not recently been documented. As far as we know, this study will be the first to make this observation, providing a major contribution to the research. For a full discussion of the impact of cash flow volatility on cash holdings, we also consider the role of corporate governance and financial constraints. Through its in-depth discussion of cash flow volatility, this study also provides evidence to clarify the role of corporate governance in cash holdings.

This study uses Taiwanese listed firms from 2006 to 2015 for which data are collected by the Taiwan Economics Journal (TEJ) to examine whether cash flow volatility is the most important factor in determining cash holdings. In general, we confirm that the most important factor in determining cash holdings is cash flow volatility (supporting the precautionary motive of cash holdings). Moreover, we also found the asymmetry of cash flow volatility to cash holdings between firms with better and with worse earnings; in other words, firms hold more (less) cash when firms have better (worse) earnings and higher cash flow volatility (supporting the behavioral finance perspective). Finally, we verified that cash flow volatility is the key determinant of cash holdings because the above findings generally hold regardless of whether a firm is with/without financial constraints or is with/without quality corporate governance. This finding is the first observation of this phenomenon, making a major contribution to the related research.

In view of the increasing volatility of global financial markets and the disturbance of uncertainty in the political environment, our empirical results are particularly meaningful to countries such as Taiwan that have smaller firms with higher operational volatility. This research helps clarify the role of cash flow volatility, helping us understand why firms hold more cash. Our results provide a useful reference for shallow financial markets such as those in South East Asia.

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Appendix

Appendix 1: Variable definitions

Variable name	Definition
Dependent variable (Y)	
Cash holding (CH)*	Ln(cash and cash equivalents/non-cash assets) Cash and cash equivalents/total assets
Explanatory variable (X)	
Cash flow (CF)	EBITDAT minus cash dividends/total assets
Cash flow volatility (CFV)**	Standard deviation of monthly stock returns over the previous two years Standard deviation of corporate earnings over the previous four years Standard deviation of ten-year average earnings over the previous ten years
Negative earnings (NEG)	Dummy variable: NEG is 1 if firms have negative earnings; otherwise 0
Control variables (Z)	
Firm size (SIZE)	natural logarithm of total assets
Firm growth (MB)	Market value to book value of equity
Research and Development (RD)***	1. R&D expenditures/total sales 2. R&D expenditures/total assets
Net working capital (NWC)	Working capital minus cash/total assets
Cash dividend(D)	Dummy variable: D is 1 if firms issue a cash dividend, otherwise 0
Capital expenditure (CE)	Fixed assets plus depreciation/total assets
Debt (LEV)	Total debt/total assets
Credit rating (RATTING)	TCRI measured by TEJ: value of RATTING ranges from 1 to 10, the smaller the value of RATTING, the better the corporate credit rating
Financial constraints (FC)****	Cash dividend payment Firm size Credit rating Financial constraint is relatively less when a firm issues a cash dividend and has both a large firm size and a better credit rating
Corporate governance (CG)*****	1. According to Chen, Kao, Tsao, and Wu (2007), the corporate governance index is constructed using CEO duality, board size, managerial shareholdings and blockholdings. The index ranges from 0 to 4, with a higher value for superior governance. 2. Ratio of independent directors (governance is better when the ratio of independent directors is higher) 3. Deviation between voting rights and cash flow rights of controlling shareholders (or blockholders) 4. Cash-flow rights of controlling shareholders (or blockholders)

Note: * non-cash assets is defined as total assets minus cash. To avoid extreme outliers, Bates et al. (2009) defined cash holdings as the cash holdings divided by non-cash holdings for firms with large cash assets. Bates et al. (2009) referred to Foley, Hartzell, Titman, and Twite (2007) and use the natural logarithm of cash holdings. We adopt both measures in our empirical results.

**: Proxy of cash flow uncertainty references (Chay and Suh (2009) and Bates et al.

(2009)).

***: R&D value is 0 for firms without R&D data (Bates et al., 2009).

****: Financial constraint measures reference (Bao et al. (2012)).

*****: Ownership structure in Taiwanese firms is more concentrated than in the U.S.

Thus, the corporate agency problem is the problem of whether or not blockholders expropriate the interests of minority shareholders (type II agency problem). In this study, we focus on the deviation between the voting rights and the cash flow rights of controlling shareholders (or blockholders), along with the cash flow rights of controlling shareholders (or blockholders).