Cash Holdings and Cash Flow Uncertainty

Lin Cho-Min

Department of Finance, Providence University, Taichung, Taiwan

Chien I-Hsin \*

Department of Accounting, Providence University, Taichung, Taiwan,corresponding author at Email address: yhchien@pu.edu.tw

Chan Min-Lee

Department of Finance, Providence University, Taichung, Taiwan

Chen Hui-Wen

Department of Finance, Providence University, Taichung, Taiwan

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**Abstract**

In view of the increasing global financial market volatilities, firms face stronger uncertainty of cash flow than before. To avoid missing investment opportunities, firms will precautionary hold cash. We accordingly conduct the empirical research to investigate whether corporate cash holding is indeed driven by uncertainty of cash flow in Taiwan listed firms during year of 2006 to 2015. Our empirical results confirm above relationship, namely, uncertainty of cash flow is the most important factor to explain why firms hold cashes. In addition, adopting the measure of earnings in Bao, et al.(2012), we conduct the analysis by different samples in terms of good/poor earnings. We found that the influence of cash flow uncertainty in cash holdings exists asymmetry between better and poorer earning sampled firms, that is, firms hold more (less) cashes when their cash flows are more volatile at relatively better (poorer) earnings. Moreover, we also verify above results not being affected by firm’s financial constraint and quality of corporate governance. Our major result that cash flow volatility plays the key role in explaining firm’s cash holding is firstly documented on relevant literature and makes the important contribution of this study. Our study is especially meaningful for those countries with smaller firm size and high uncertainty of business operation coming from increasing global financial markets turbulent and political disturbances, such as Taiwan. Also, our empirical results could provide useful reference to those countries with shallow-plate market such as South East Asia.

Keywords: Cash Holding, Cash Flow Uncertainty, Corporate Governance

1. Motivation

The increasing evidences reveal that corporate holds more cashes for past decades. Amess, Banerji and Lampousis (2015) think the increasing cash holding becomes a global phenomenon. From 1990s to 2000s, the increasing amount of cash holdings take up to 10% of the US GDP (Dittmar and Mahrt-Smith, 2007) and the cash holdings in US firms increase with annual 0.46% on average from 1980 to 2006 (Bates, Kahle and Stulz, 2009). Corporate cash holdings in Japan and South Korea take 44% and 34% of their GDPs respectively, and Europe, Mainland China, and Taiwan also have the trend of rising cash holdings (Ferreira and Vilela, 2004; Chen, Chen, Schipper, Xu, and Xue, 2012; Kuan, Li, and Liu, 2012). Kuan et al. (2012) mentions that the average level of cash holdings in Taiwan listed firms has exceeded most of the developed countries.

The interesting question is why corporate holds more internal cashes given lower rate of return on cash ? As we know, holding cashes generate opportunity costs, on the contrary, it might lose good investment opportunity when there is no cash available for the investments resulting in under-investment problems. Based on above, there should exist an optimal level of cash holdings[[1]](#footnote-1). Thus, it seems that holding cashes should be able to strengthen efficiency of cashes and enhance firm value when firms hold an appropriate level of cashes, therefore, an optimal level of cashes exist[[2]](#footnote-2). As mentioned earlier, current studies document the increasing trend of cash holdings since year of 2000 (Bates, et al., 2009; Juan and Yurdagul, 2013). Bates et al. (2009) indicates that the increasing cash holdings mainly come from precautionary motive which firms view cashes as a cushion to cash flow uncertainty or cash flow shock[[3]](#footnote-3). Opler, Pinkowitz, Stulz, and Williamson (1999) point out that firms with high growth and high risks of investment earnings would hold more cash, Bates et al. (2009) have similar findings that firms with high risks hold more cash[[4]](#footnote-4). Juan et al. (2013) also discovers the uncertainty (risks) to be one of factors affecting firm’s cash holdings. Even current studies found firms with relatively high risk will hold more cashes for precautionary motive or lower transaction costs motive, no literature discuss the key determinant in influencing firm’s cash holdings. Our first purpose tends to investigate whether uncertainty is the key factor affecting firm’s cash holdings.

Almeida, Campello, and Weisbach (2004) support that firms will increase cash holdings when they have more cash flows(earnings), that is, cash holding has a positive response to cash flow (positive cash flow sensitivity of cash) while Riddick and Whited (2009) found the 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 the linear relationship between cash flow and cash holdings. Instead of linearity between cash flow and cash holdings, Bao, Chan, and Zhang(2012) thinks it exists non-linear relationship. They argue that the response of cash holdings to cash flow depends upon whether firms are at positive or negative earnings. Bao, et al. (2012) empirically found the asymmetry of cash flow sensitivity of cash, that is, the cash flow sensitivity of cash exists different results on positive or negative earnings. We accordingly examine whether the impact of cash flow uncertainty on cash holdings has asymmetric effect between firms with positive and negative earnings. So far, there is no literature to discuss the asymmetry of corporate cash holding to firm’s risks (volatility) which will be the second purpose of this study. Our empirical results should be the initiate observation and make the major contribution of related topic.

Taiwan is the shallow financial market due to its small market size and high speculation. Given those characteristics, Taiwan financial market is easily influenced by market risks and becomes volatile in face of increasing turbulence of political environments and global financial markets. Therefore, it is especially meaningful to use Taiwan listed firms in examining how cash flow uncertainty affects corporate cash holdings because it not only clarifies the role of cash flow uncertainty in cash holdings but also help understand 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 to corporate cash policy in other shallow financial markets such as South East Asia.

**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 due to risks and incomplete capital markets, in addition to agency problems that constrain 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)[[5]](#footnote-5). 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)[[6]](#footnote-6).

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 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, and to prevent crises or breaches of contract due to financial dilemmas, companies are thus holding increasingly more cash. In addition, Brown and Kapadia (2007) indicated that new listed companies have a higher idiosyncratic risk of stock remuneration, 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. Furthermore, when a company faces more uncertainty, it relies more on cash flow. This paper focuses on 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. In reference to the study of Bao et al. (2012), in addition to claiming that cash flow uncertainty would positively affect a company's cash holdings (support a precautionary motive), this paper further divides a company’s earnings into positive and negative earnings. This paper claims that when a company has positive earnings, the impact of cash flow uncertainty on cash holdings would decrease. Put otherwise, a company would decrease cash holdings (increase investment) if its previous investment generated positive financial return; increases in cash flow uncertainty are mainly due to increases in positive or high (earnings) cash flow fluctuations. 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.

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.

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 becomes weak.

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

H2b: For companies with poor earnings, the positive impact of cash flow uncertainty on cash holdings becomes strong (from the perspective of precautionary motive).

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

**Additional Test**

This paper focuses on testing two motives (hypotheses) about cash holdings: the precautionary motive and agency problem motive. The precautionary motive hypotheses mainly examine the precautionary motive for holding cash. Agency theory is discussed below. It has been mentioned that holding too much cash can lead to an increase in the opportunity cost of cash (because the deposit rate is less than profit rate of investment); moreover, holding too much cash can also lead to higher agency costs. However, on the other hand, holding too little cash can result in underinvestment (or missing good 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 one hand, the opportunity cost of a company holding too much cash is to give up the reward of investment; on the other hand, from the perspective of corporate governance, a company's high-level managers may abuse the company's funds to seek personal self-interest, which can reduce the value of the company, thus hurting the interests of shareholders (investors) (Jensen, 1986, free cash flow hypothesis). In other words, too much cash may induce managers to misuse cash for their own interests (such as investments with negative NPV), which will reduce the value of the company and damage the interests of shareholders (investors), thereby leading to agency problems between managers and shareholders (Jensen and Meckling, 1976; Jensen, 1986); in contrast, companies with good corporate governance have less agency costs, use the company's cash more efficiently, and thereby increase the value for shareholders (the company). For example, if a company's governance quality is quite good, the board fully executes its oversight function; then, even if the company holds a lot of cash, it should not generate too high agency costs with the board strictly monitoring the behavior of managers[[7]](#footnote-7). In contrast, for companies with poor corporate governance (high agency costs), too much cash will produce high agency costs.

In addition, from the perspective of financing constraints, in general, good (poor) corporate governance indicates a non-serious (serious) asymmetrical information situation; thus, external financial constraints are low (high), and external financial costs are low (high), meaning that a company itself does not need (needs) to hold too much cash. A study regarding multinational companies conducted by Dittmar, Mahrt-Smith, and Servaes (2003) found that companies with poor corporate governance (high agency costs) hold more cash[[8]](#footnote-8). 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 little cash.

Kuan et al. (2012) used quantile regression to explore how the corporate governance of Taiwan's listed companies affects the cash level of companies with high and low cash flow. The empirical results indicate that if companies with low cash flow have good corporate governance (less excess control rights), they hold more cash (consistent with trade-off theory and financing theory); in contrast, if companies with low cash flow have good corporate governance (less excess control rights), they hold less cash (consistent with free cash agency theory). Nevertheless, when studying American companies, Bates et al. (2009) note that agency problems cannot significantly explain why companies hold increasingly more cash. In conclusion, there is no consensus about the impact of corporate governance on cash holdings in the previous literature.

On the other hand, Amess, et al. (2015) developed a trade-off model for a company with limited financing to hold cash owing to possible investment needs and for managers’ improper use of cash, trying to emphasize the importance of corporate governance. Han and Qiu (2007) revealed that companies with financial constraints hold more cash when cash flow uncertainty increases, whereas companies without financial constraints do not hold much cash when cash flow uncertainty increases. In view of the emphasis on the importance of corporate governance in corporate cash holdings in the previous literature, this paper intends to explore the impact of corporate governance and financing constraints on cash holdings on the basis of the foundational model (Equation 2). In other words, this paper will further examine hypotheses 1 and 2 by categorizing samples according to the quality of corporate governance and the level of financing constraints to clarify the role of corporate governance in cash holdings. Finally, this paper also refers to Kuan et al. (2012) to explore the level of cash holdings and try to understand whether companies with high cash holdings and those with low cash holdings respond differently to cash flow uncertainty.

**Empirical model and variable definitions**

This research uses annual data of Taiwanese firms listed in TSE (Taiwan Security Exchange) during period of 1990 to 2015. The missing value and some regulated industries such as financial industry and public utility are excluded and finally end up with 4,266 firm-year observations in this study. Data source is from Taiwan Economic Journal (TEJ). We formulate the empirical models from equation (1) to (4) by referring to Bates, et al.(2009),Kuan et al. (2009),Bao et al. (2012) and Harford et al. (2008), and each equation has been estimated with dependent variable defined as cash holdings (CH), change of cash holdings (△CH) and extreme cash holdings (EXCH)[[9]](#footnote-9). Following Petersen (2009) and Gow, Ormazabal, and Taylor (2010), two-way cluster-robust standard errors is adopted in equation (1) and (2) and related variable definitions are shown in Appendix 1. We also winsorized data at extremely top 1% and bottom 1%. The empirical models are shown as follows.

The definitions of all variables in Equations are defined in the Appendix. The suffix i and t of each variable are denoted as firm and year respectively; j is the number of control variable, and Z is the control variable.

We estimate Equation (1) first and followed by Equation (2) to examine hypothesis 1. If cash flow uncertainty in equation (1) turns out to be significantly positive and stays to be significantly positive, hypothesis 1 is empirically confirmed, meaning the cash flow uncertainty is the most important factor in influencing corporate cash holdings. As for hypothesis 2 of poor earnings, H2b will be empirically supported if β5 is significantly positive in equation (2) On the contrary, H2.1b is empirically supported if β5 is significantly negative in Equation (2). As for hypothesis 2 of good earnings ( H2a and H2.1a), we rerun the Equation (2) with replacing NEG with POS as the firms with better earnings.

**Empirical results**

**Descriptive Statistic**

Table 1 is the summary of statistics for all variables. The mean value (13.91) of

cash holdings (CH) is greater than its median (11.54) implying that most of the firms hold less cashes but some hold large amount of cashes. 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 research period. The mean value (10.83) of cash flow uncertainty (CFV) is also greater than its median (10.08) suggesting that earnings volatilities of some firms are relatively large. Corporate governance (CG-MEAN) in Taiwan is generally not good enough with mean of 2.45 and median of 2.00 (positive skew) The standard deviation of 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 large deviation in IND\_CG among firms, in another word, some firms have high independent directors while some have low. However, this large deviation will get improved followed by the regulation of minimum number of independent directors to be publicly listed.

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| **Table 1 Descriptive statistic** | | | | | | | | |
| **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 observation 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 25percentile, Median (Q50) is the median value, Q3 is the bottom 25percentile, 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 past two years(definition 1), CFV4 is cash flow uncertainty based on the standard deviation of EBITDA over past four years(definition 2), CFV10 is cash flow uncertainty based on the standard deviation of industry average earnings over past ten years(definition 3);CG\_INDEX is the corporate governance index considering the 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 R&D expenditure to total sales, NWC is ratio of net operation cash (total operation cash minus cash) to total assets, D is dummy of cash dividend (if firm issues cash dividend, D is 1, otherwise D is 0), CE is ratio of capital expenditures (sum of fix assets and depreciations) to total assets, LEV is ratio of total debt to total assets, RATTING is credit ratings.

The definition of CG\_INDEX is based on the study of Chen et al. (2007); the IND\_CG is a dummy variable and it equals 1 when firms have independent directors.

**Bivariate analysis**

As shown in Table 2, we conduct bivariate analysis of firm’s cash holdings in terms of various variables such as earnings, cash flow (CF), cash flow uncertainty (CFV) and other control variables as well. Panel A shows that mean and median values of p values of CF0 for both T-test and Wilcoxon-test. The mean values for CF0 are 13.4199 and 13.9494 with p value being 0.3996 while the median values for CF0 are 10.1400 and 11.6200 with p value being 0.0323 respectively implying that firms with positive earnings hold less cash than those with negative earnings, but only significant under 5% level in Wilcoxon test. Panel B indicates that p values of CF50 for both T-test and Wilcoxon-test are 0.0000 and 0.0000 respectively implying that firms with better earnings hold less cash than those with poorer earnings. Panel C shows that 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 those with higher cash flow uncertainty, but only significant under 10% level in T-test. Panel D conducts the similar test as Panel C, but uses different measure of cash flow uncertainty CFV4 and obtains different findings. Results show that p values of CFV4 for both T-test and Wilcoxon-test are 0.0004 and 0.0010 respectively, suggesting that firms with less cash flow uncertainty hold more cash than those with higher cash flow uncertainty. Panel E shows the cash holdings to have significantly different between high and low growth firms, that is, high growth firms hold more cash than those low growth firms. Panel F evidences that large firms hold significantly less cash compared with small firms. Panel G indicates that cash holdings exist significant difference between firms with good and poor credit rating, that is, firms with poor rating hold significantly less cash than those with good rating.

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| **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 past 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 past 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 earning is greater than zero, otherwise 0; CF50 is 1 for firms with better earnings if earning is above median of earnings, otherwise 0; D\_CFV2 is 1 for firms with unstable cash flow if cash flow uncertainty CFV2 is greater than its past 2-year median, otherwise 0; D\_CFV4 is 1 for firms with unstable cash flow if cash flow uncertainty CFV4 is greater than its past 4-year’s 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 firms with large size if SIZE is greater than its median, otherwise 0; D\_RATTING is 1 for firms with poor credit rating if RATTING is greater than its median, otherwise 0; Difference is the variable difference of two groups based on above definitions.

Note 2: T-test is the parametric tests of mean values, Wilcoxon-test is the nonparametric tests of median value.

Table 3 shows the change of cash holdings results that Model 1 is without considering control variables, Model 2 is with control variables and Model 3 is additionally considering year and industry from Model 2. All three models indicate that cash flow uncertainty (CFV2) has a significantly positive influence on change of cash holdings(ΔCHt) meaning that firms with more volatile cash flow hold more cash than those with less volatile cash flow, confirming hypothesis 1. Moreover, change of cash holdings at current period (ΔCHt) is negatively correlated with lagged one period of ΔCHt (ΔCHt1) implying that current change of cash holdings will be increased if change of cash holdings at previous period is less. The lagged one period cash holdings (CHt1) has a significantly negative impact on change of cash holdings (ΔCHt), suggesting that current change of cash holdings will be more when firms hold less cash at previous period. Cash flow has a significantly positive impact on the change of cash holdings, suggesting that firms with high cash flows (earnings) will hold more cashes. Cash flow uncertainty (CFV2) has a significantly positive correlation with the change of cash holdings, that is, firms will hold more cashes when firms’ cash flow are highly volatile.

Other control variables have negative impacts on the change of cash holdings such as firm size, firm growth, net working capital, capital expenditures, debt ratio and credit rating while cash dividend has a positive influence on the change of cash holdings, but insignificant.

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| Table 3 The cash flow volatility on change of cash holdings (without interaction terms, **)** | | | |
| **ΔCHt** | Model 1 | Model 2 | Model 3 |
| Cons | -0.2047 | 9.7645\*\*\* | 12.8623\*\*\* |
|  | (0.6000) | (0.0000) | (0.0000) |
| ΔCHt1 | -0.1381\*\*\* | -0.1368\*\*\* | -0.1149\*\*\* |
|  | (0.0000) | (0.0000) | (0.0000) |
| CHt1 | -0.1093\*\*\* | -0.1496\*\*\* | -0.1950\*\*\* |
|  | (0.0000) | (0.0000) | (0.0000) |
| CF | 0.1076\*\*\* | 0.1493\*\*\* | 0.1342\*\*\* |
|  | (0.0000) | (0.0000) | (0.0000) |
| CFV2 | 0.1229\*\*\* | 0.1324\*\*\* | 0.0670\*\*\* |
|  | (0.0000) | (0.0000) | (0.0000) |
| SIZE |  | -0.2603\*\* | -0.3700\*\*\* |
|  |  | (0.0470) | (0.0060) |
| MB |  | -0.3181\*\*\* | -0.1876\* |
|  |  | (0.0090) | (0.0700) |
| RD\_SELL |  | 0.0049\*\*\* | 0.0037\*\* |
|  |  | (0.0000) | (0.0490) |
| NWC |  | -0.0850\*\*\* | -0.1000\*\*\* |
|  |  | (0.0000) | (0.0000) |
| D |  | 0.0481 | -0.0397 |
|  |  | (0.8740) | (0.8950) |
| CE |  | -0.2616\*\*\* | -0.2623\*\*\* |
|  |  | (0.0000) | (0.0000) |
| LEV |  | -0.0414\*\*\* | -0.0535\*\*\* |
|  |  | (0.0000) | (0.0000) |
| RATTING |  | -0.3275\* | -0.3748\*\* |
|  |  | (0.0600) | (0.0310) |
| Obs | 4266 | 4266 | 4266 |
| YEAR | NO | NO | YES |
| INDUS | NO | NO | YES |

Note: ΔCHt is the change of cash holdings at current period; CHt1 is lagged one period of CH; ΔCHt1 is the change of current cash holdings and lagged one period cash holdings; Obs is the number of observations; YEAR is a dummy variable of year; INDUS is a dummy variable of industry; other variable definitions could be referred to Appendix 1.

For hypothesis 2, Table 4 is to examine the impacts of cash flow volatilities on change of cash holdings at various measures of corporate earnings from Model 1 to Model 4. General speaking, firms hold more(less) cashes when they have better (poor) earnings except for Model 3 and Model 4. Looking at results with positive earnings measured by CFPOS0CFV2, CFPOS10CFV2, CFPOS30CFV2 and CFPOS50CFV2, cash flow volatilities have significantly positive influences on the change of cash holdings at firms with good earnings suggesting that firms with good earnings will hold more cashes resulting from high cash flow volatilities. For those firms with poor earnings measured by CFNEG0CFV2 and CFNEG10CFV2, cash flow volatility has a significantly negative impact on the change of cash holdings, implying that firms with negative earnings will hold less cashes when the cash flow is unstable. Except for results of earnings measured by CFNEG30CFV2 and CFNEG50CFV2, most empirical results conclude that cash flow volatilities at different measures of earnings have different influences on the change of cash holdings, confirming hypothesis 2.1a/b.

The significantly negative relationship between change of current cash holdings (ΔCHt) and the change of cash holdings at lagged one period (ΔCHt1) suggests that current cash holdings will be increased if change of cash holdings last period is less. The negative relationship between lagged one period cash holdings (CHt1) and change of cash holdings (ΔCHt) represents that current cash holdings will be more if firms hold less cashes at previous year.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 4 The cash flow volatility on change of cash holdings (with interaction terms) | | | | |
| **ΔCHt** | Model 1 | Model 2 | Model 3 | Model 4 |
| Cons | 0.9227\*\* | 0.9214\*\* | 0.8676\*\* | 0.8265\*\* |
|  | (0.0160) | (0.0160) | (0.0180) | (0.0250) |
| ΔCHt1 | -0.1350\*\*\* | -0.1349\*\*\* | -0.1360\*\*\* | -0.1350\*\*\* |
|  | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| CHt1 | -0.1156\*\*\* | -0.1157\*\*\* | -0.1145\*\*\* | -0.1127\*\*\* |
|  | (0.0000) | (0.0000) | (0.0000) | (0.0000) |
| CFV2 | -0.0191 | -0.0176 | 0.0289 | 0.0508\* |
|  | (0.6490) | (0.6680) | (0.3580) | (0.0870) |
| CFNEG0CFV2( | -0.0150\*\* |  |  |  |
|  | (0.0110) |  |  |  |
| CFPOS0CFV2( | 0.0140\*\*\* |  |  |  |
|  | (0.0000) |  |  |  |
| CFNEG10CFV2( |  | -0.0149\*\*\* |  |  |
|  |  | (0.0080) |  |  |
| CFPOS10CFV2( |  | 0.0139\*\*\* |  |  |
|  |  | (0.0000) |  |  |
| CFNEG30CFV2( |  |  | -0.0059 |  |
|  |  |  | (0.1680) |  |
| CFPOS30CFV2( |  |  | 0.0109\*\*\* |  |
|  |  |  | (0.0000) |  |
| CFNEG50CFV2( |  |  |  | 0.0004 |
|  |  |  |  | (0.9010) |
| CFPOS50CFV2( |  |  |  | 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 standard deviation of monthly stock returns over past two years; CFNEG0CFV2 is the interaction between CFV2 and dummy variable of negative earnings; CFNEG10CFV2 (or CFNEG30CFV2 or CFNEG50CFV2) are the interactions between CFV2 and dummy variables of the low 10 percentile ( or low 30 percentile or low 50 percentile) earnings; CFPOS0CFV2 is the interaction between CFV2 and dummy variable of positive earnings; CFPOS10CFV2 (or CFPOS30CFV2 or CFPOS50CFV2) are the interactions between CFV2 and dummy variables of the top 10 percentile ( or top 30 percentile or top 50 percentile) earnings; other variables are the same definitions as these in Table 2.

Table 5 shows the similar results as Table 4 but additionally considers control variables, dummy variable of industry and dummy variable of year. Results indicate that cash flow volatility has a significantly positive impact on the change of cash holdings when firm has a better earning suggesting that unstable cash flow volatility will push firms to hold more cashes when firm has a better earning. Besides, when negative earnings are measured by zero earnings (CFNEG0CFV2) and bottom 10 percentile (CFNEG10CFV2), cash flow volatility has a significantly negative influence on the change of cash holdings when firm has a poor earning suggesting that firms with poor earnings will hold less cashes followed by unstable cash flow volatility. Except for results of CFNEG30CFV2 and CFNEG50CFV2, others generally suggest cash flow volatilities at better and worse earnings have different impacts on the change of cash holdings, confirming behavioral finance hypotheses 2.1a and 2.1b, indicating manager is risk averse in firm with better firm performance and manager is risk taking in firm with worse firm performance instead.

The significantly negative relationship between change of current cash holdings (ΔCHt) and change of cash holdings at lagged one period (ΔCHt1) tells that current cash holdings will be increased if change of cash holdings at previous period gets less. The negative relationship between lagged one period cash holdings (CHt1) and change of cash holdings (ΔCHt) represents that current cash holdings will be more if firms hold less cashes at previous year.

As for the control variables, those variables have negative impacts on change of cash holdings such as firm size, firm growth, net working capital, capital expenditure, debt and credit rating while R&D has a significantly positive effect on change of cash holdings. Cash dividend payout has a positive effect on change of cash holdings but not significant, suggesting that cash holdings will not be affected by cash dividend.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 5 The cash flow volatility on change of cash holdings (with interaction terms **)** | | | | |
|  | 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) |
| ΔCHt1 | -0.1135\*\*\*(0.0010) | -0.1135\*\*\*(0.0010) | -0.1140\*\*\*(0.0010) | -0.1122\*\*\*(0.0010) |
| CHt1 | -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  ( | -0.0121\*(0.0730) |  |  |  |
| CFPOS0CFV2  ( | 0.0159\*\*\*(0.0000) |  |  |  |
| CFNEG10CFV2  ( |  | -0.0118\*(0.0700) |  |  |
| CFPOS10CFV2  ( |  | 0.0158\*\*\*(0.0000) |  |  |
| CFNEG30CFV2  ( |  |  | -0.0037 (0.4390) |  |
| CFPOS30CFV2  ( |  |  | 0.0128\*\*\*(0.0000) |  |
| CFNEG50CFV2  ( |  |  |  | 0.0024(0.4890) |
| CFPOS50CFV2  ( |  |  |  | 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) |
| 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) |
| RATTING | -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 interactions of CFV2 and various earnings measures are the same as these defined in Table 4; other control variables are the same as these defined in Table 3.

Greater (less) financial constraints mean that firms are more difficulty (less difficulty) to raise capitals from capital markets or banks. Thus, firms would hold more cashes when they are not easier to raise funds. In view of this, 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 6[[10]](#footnote-10) provides results of the effect of cash flow volatilities on change of cash holdings in terms of different measures of financial constraints. Most of results in Table 6 support the similar findings with those without considering financial constraints except for CFNEG50CFV2 in Model 2. Above results show that the effect of cash flow volatilities on change of cash holdings will not depend upon whether firms are with or without financial constraints which imply the importance of cash flow volatility to cash holdings.

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| Table 6 The cash flow volatility on change of cash holdings considering financial constraints (interaction variable only) | | | | |
|  | with or without cash dividend | high and low growth firms | large and small firm size | high and low credit rating |
| **Positive vs. negative earning** | 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] |
|  |  |  |  |  |
| **10 percentile earning** |  |  |  |  |
| 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 The cash flow volatility on change of cash holdings considering financial constraints (interaction variable only) (continued)

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | with or without cash dividend | high and low growth firms | large and small firm size | high and low credit rating |
| **30 percentile earning** | 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 percentile earning** |  |  |  |  |
| 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 these in Table 5.

Note 2: Parentheses ( ) represents p values for results without financial constraint sample which is firms with cash dividend (Panel A), high growth firms(Panel B), large firms(Panel C), good credit rating firms(Panel D); Brackets [ ] represents p values for results with financial constraint sample which is firms without cash dividend(Panel A), low growth firms(Panel B), small firms(Panel C) and poor credit rating firms(Panel D).

Firms would hold less cashes when they have better corporate governance and have lower costs of external capitals. In view of this, we further examine whether the impact of cash flow volatility on cash holdings depends upon corporate governance. We use corporate governance index and ratio of independent directors as proxies of corporate governance. As shown in Table 7, our empirical results reveal similar findings as those without considering corporate governance except for the positive coefficient of CFNEG50CFV2 in Model 1 regardless of good or poor earnings. Above results indicate that the effect of cash flow volatilities on change of cash holdings will not depend upon whether firms are good or poor corporate governance. Again, the importance of cash flow volatility is strengthened to cash holdings.

|  |  |  |
| --- | --- | --- |
| **Table 7 The cash flow volatility on change of cash holdings considering corporate governance(interaction variable only)** | | |
|  | Corporate governance index | Ratio of independent director |
| **Positive vs. negative earning** | 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 percentile earning** |  |  |
| 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 percentile earning** |  |  |
| 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 percentile earning** |  |  |
| 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 these in Table 5.

Note 2: Parentheses ( ) represents p values for results with good corporate governance sample which is firms with high value of 3 or 4 at governance index (Model 1) and high ratio of independent directors (Model 2); Brackets [ ] represents p values for results with poor corporate governance sample which is firms with low value of 0,1 or 2 at governance index(Panel A) and low ratio of independent directors (Panel B).

**Conslusions**

Extant literature (Bates, et al., 2009; Juan and Yurdagul, 2013) point out that firms hold more cashes than before. For example, Exxon Mobil and Microsoft hold more than 30 billions US dollars in cashes at year of 2006 (Bates et al., 2009). It leaves unsolved that holding too much cashes are not only to increase opportunity costs of cashes but also to create problem whether managers at firms with poor governance will squander cashes that are preserved for future investments. Above situations will lower firm values (especially for firms with relatively high financial constraints) and harm interests of shareholders, that is, agency problem of holding cashes. Then, why would firms hold more cashes? One potential reason for high cash holdings is higher cash flow (earnings) volatility in face of increasing uncertainty. Firms hold more cashes for precautionary motive to avoid miss favorable investments. Even there are literature discussing the cash flow volatility, it is considered as control variable in cash holdings. In view of the increasing volatility in cash flow, this study is the first to explore in depth whether cash flow volatility is the most important factor to cash holdings from the viewpoint of cash flow volatility. Moreover, we argue that the impact of cash flow volatility in cash holdings is non-monotonic, that is, we think this impact should have asymmetric effect between positive and negative earnings. Accordingly, we refer to “asymmetric cash flow sensitivity of cash holdings” in Bao, et al.(2012) and divide sample to firms with better and with poorer earnings to further examine whether there exists symmetric effect between positive and negative earnings in the relation of cash flow volatility in cash holdings. Even Bao, et al. (2012) confirmed the asymmetric sensitivity of cash holding to cash flow ~~volatility~~, the issue of asymmetric sensitivity of cash holding to “cash flow volatility” has not documented in current studies. As we know of, this study will be the first observation which makes the major contribution of this research. For fully discussion of the impact of cash flow volatility on cash holdings, we also consider the role of corporate governance and financial constraints in this impact. Through this in-depth discussion of cash flow volatility, it also provides evidences to clarify the role of corporate governance in cash holdings.

This study uses Taiwanese listed firms during 2006 to 2015 which data are collected from Taiwan Economics Journal (TEJ) to examine whether cash flow volatility is the most important factor in the determinant of cash holdings. Generally speaking, we confirm the most important factor in the determinant of 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 poorer earnings, in another word, firms hold more (less) cashes when firms have better (poorer) earnings and higher cash flow volatility (supporting the perspective of behavioral finance). Finally, we verified that cash flow volatility is the key determinant of cash holdings since above findings generally hold regardless with/without financial constraints or with/without quality of corporate governance. This finding is the first observation and makes this study the major contribution in related research.

In view of increasing volatility of global financial markets and disturbance of politically environmental uncertainty, our empirical results are especially meaningful to countries that have firms with smaller size and with higher volatility in operation, such as Taiwan. This research helps clarify the role of cash flow volatility which also help answer why firms hold more cashes. Our results certainly provide useful reference to shallow financial markets such as South East Asia.

**Appendix 1 Variable definitions**

|  |  |
| --- | --- |
| Variable name | definition |
| Dependent variable (Y) | |
| Cash holding (CH)\* | 1. Ln(cash and cash equivalents/non cash assets) 2. cash and cash equivalents/total assets |
| Explanatory variable (X) | |
| Cash flow (CF) | EBITDAT minus cash dividends/total assets |
| Cash flow volatility (CFV)\*\* | 1. standard deviation of monthly stock returns over past two years 2. standard deviation of corporate earnings over past four years 3. standard deviation of ten-year average earnings over past 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 Developments (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 cash dividend, otherwise 0 |
| Capital expenditure (CE) | Fixed assets plus depreciations/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 value of RATTING means the better of corporate credit rating |
| Financial constraints (FC)\*\*\*\* | 1. cash dividend payment 2. firm size 3. credit rating   Financial constraint is relatively less when firm issues cash dividends, large firm size and better credit rating |
| Corporate governance (CG)\*\*\*\*\* | 1. According to Chen, Kao, Tsao, and Wu (2007), corporate governance index is constructed by CEO duality, board size, managerial shareholdings and blockholdings. The index ranges from 0 to 4 with a higher value for the better governance.  2. ratio of independent directors (governance is better when ratio of independent directors is higher)  3. deviation between voting right and cash flow right of controlling shareholders (or blockholders)  4. cash flow rights of controlling shareholders (or blockholders) |

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

\*\*: Proxy of cash flow uncertainty is referred to 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 are referred to Bao et al. (2012).

\*\*\*\*\*: Ownership structure in Taiwanese firms is more concentrated than in USA. Thus, corporate agency problem is the problem whether blockholders expropriate interests of minority shareholders or not (type II agency problem). In this study, we focus on the deviation between voting rights and cash flow rights of controlling shareholders (or blockholders) as well as cash flow rights of controlling shareholders (or blockholders).

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1. In another way, holding cashes could avoid high costs of raising capital due to financing or paying back debts(Acharya, Almeida, and Campello, 2007). [↑](#footnote-ref-1)
2. Trade-off theory think that an optimal level of cashes exists when the marginal benefits and marginal costs of cash are equal, however, pecking order theory (Myers and Majluf, 1984) do not support the existence of optimal level of cashes. [↑](#footnote-ref-2)
3. Most studies support the motives of cash holdings including transaction motive, precautionary motive, tax motive and agency motive. [↑](#footnote-ref-3)
4. Bates et al (2009) found firms without paying dividends, new listing and facing higher risks will hold more cashes. [↑](#footnote-ref-4)
5. The 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. [↑](#footnote-ref-5)
6. From 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. [↑](#footnote-ref-6)
7. From the point of view of free cash flow, effective corporate governance can reduce agency problems caused by free cash flow through decreasing companies’ cash holdings. [↑](#footnote-ref-7)
8. Dittmar 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 less. Moreover, Lee and Powell (2011) revealed that the value of cash becomes lower when companies hold more cash or hold cash for a longer time. [↑](#footnote-ref-8)
9. According 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 right which quantile regression analysis is appropriate adopted. [↑](#footnote-ref-9)
10. Due to space limits, we only report the interaction results. [↑](#footnote-ref-10)