A New Determinant of Stock Price Crash Risk: Evidence from Corporate Cash Holding

Woraphon Wattanatorn*
Department of Finance, Thammasat Business School,
Thammasat University, Bangkok, Thailand.

Tatre Jantarakolica
Faculty of Economics, Thammasat University, Bangkok, Thailand.

Pornsit Jiraporn
School of Graduate Professional Studies, Pennsylvania State University, USA.

ABSTRACT

This study explores the role of corporate cash holding and stock price crash risk. Grounded on agency philosophy, the firms holding a large portion of cash are more likely to be faced with agency problems and hence asymmetric information. Consequently, this study applies the level of corporate cash holding as a proxy for asymmetric information. Based on the U.S. sample between 1991 and 2019, the results demonstrate a positive association between the corporate cash holding and stock price crash risk. Therefore, the large cash firms with large cash holdings are more prone to stock price crash risk. To ensure our results are robust, two traditional stock price crash risk measures are applied while we further add one extra stock price crash risk to improve the test reliability. We further alleviate the endogeneity issue by performing 2SLS. We find the results remain unchanged.

Keywords: Stock price crash risk; cash holding; corporate cash holding.

Received 10 April 2024 | Revised 15 July 2024 | Accepted 2 September 2024.

1. INTRODUCTION

A large drop in stock price called stock price crash risk (hereafter "crash risk") is a risk or uncertainty when firms experience a negative skewness in asset returns due to the asymmetric information between management and outside investors. This may incentivize the management to either block or postpone bad news, particularly when the firm is underperforming, to the market (Jin & Myers, 2006; Kothari, Shu, & Wysocki, 2009). As time passes, when the bad news accumulates and surpasses some threshold, it can trigger a significant plummet in the stock price (Chang, Chen, & Zolotoy, 2017; Habib, Hasan, & Jiang, 2018). As a consequence, the crash risk is a critical issue for a broad range of parties including academics, practitioners, and regulators (Xu, Jiang, Chan, & Yi, 2013).[1]

[1] Some define crash risk as a choice of a tailed risk measure (Bollerslev, Todorov, & Xu, 2015; Kelly & Jiang, 2014).

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

One traditional way to prevent firms from experiencing uncertainty is to hold cash (Keynes & Waeger, 1936).[2] According to precautionary motivation, firms sacrifice potential investment opportunities by holding excessive cash in order to protect against unexpected situations and hence lower firms' uncertainty. Among researchers who support this preventive motivation, Morris (1983) suggests a negative association between firms' level of cash and firm specific risk which is supported by the subsequent finding of Campello M. (2003) who demonstrates that the high cash holding firms show less non-systematic risk. Furthermore, corporates can strategically avoid extreme losses by holding excessive cash (Hambrick & Finkelstein, 1987). On the other hand, cash holding is encouraged by asymmetric information—agency conflict between managers and outside investors. As suggested by Jensen (1986), cash holding is driven by asymmetric information. Managers prefer the future flexibility of investment decisions. Hence, the firms with large set of investment opportunities hold more cash. In addition, firms with weak governance experiencing asymmetric information are expected to hold more cash than well controlled firms (Acharya, Almeida, & Campello, 2007).

Unlike the aforementioned literature, this study examines the association between cash holding and stock price crash risk. As crash risk is driven by asymmetric information, we apply the level of cash holding to proxy for firm's asymmetric information according to the agency-conflict hypothesis. Based on our U.S. sample between 1990 and 2019, the results underscore the significance of cash holding in stock price crash risk. We discover a positive association between cash holding and stock price crash risk in that the higher level of cash holding increases crash risk. Our findings are in the line with agency-conflict motive.

The paper is organized as follows. Section 2 shows literature review and hypothesis development. Section 3 briefly discusses data and sample. Section 4 presents the empirical and robustness test. Section 5 addresses an endogeneity issue while the last section concludes the paper.

2. LITERATURE REVIEW AND HYPOTHESIS DEVELOPMENT

2.1 Crash risk

We apply two traditional crash risk measures—the negative skewness (NSKEW) and down-to-up volatility ratio (DUVOL) following crash risk literature (Chen et al., 2001; Kim et al., 2011; Chang et al., 2017). To formulate crash risk measures, we follow Chen et al. (2001) and Hutton et al. (2009) to calculate residual stock return obtained from market expanded model as shown in Eq. (1). We then calculate the firm specific weekly return as the natural logarithm of weekly residual stock return plus 1 as shown in Eq. (2).

$$r_{j,\tau} = \alpha_i + \beta_i r_{m,\tau-2} + \gamma_i r_{m,\tau-1} + \delta_i r_{m,\tau} + \theta_i r_{m,\tau+1} + \vartheta_i r_{m,\tau+2} + e_{i,\tau} \quad (1)$$

$$w_{i,\tau} = \ln(e_{i,\tau} + 1) \quad (2)$$

[2] According to General theory (Keynes, 1936), there are three main reasons for the firm to conserve cash including transaction purpose, precautionary purpose, and speculative purpose.

.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

where $e_{i,\tau}$ is the residual stock return obtained from expanded index model and $w_{i,\tau}$is the firm specific weekly return. We then compute the NSKEW and DUVOL based on firm specific weekly return as shown in Eq. (3) and (4) respectively.

$$NSKEW_{i,t} = \frac{-[n(n-1)^{3/2}\sum_{\tau=1}^{T} w_{i,\tau}^3]}{[(n-1)(n-2)(\sum_{\tau=1}^{T} w_{i,\tau}^2)^{3/2}]} \quad (3)$$

$$DUVOL_{i,t} = log\left[\frac{(n_d-1)\sum_{\tau=DOWN}^{T}\sigma_{i,\tau}}{(n_u-1)\sum_{\tau=UP}^{T}\sigma_{i,\tau}}\right] \quad (4)$$

where τ indicates the τ^{th} week and n represents the total number of weeks in specific year *t*. $NSKEW_{i,t}$ represents the degree of firm's exposure to crash risk. Next, the down-to-up volatility ($DUVOL_{i,t}$) is the logarithm ratio between the summation of the standard deviation of weekly return ($\sigma_{i,\tau}$) of the DOWN weeks to that of the UP weeks of firm i during year t. The UP (DOWN) week is the weekly return, which is more (less) than the weekly average of firm i during year t. n_d (n_u) is the number of UP (DOWN) weeks.

To ensure the results are robust, we further add a binary dummy variable ($ICRASH_{i,t}$) as alternative crash risk measure. If the firm experiences at least one crash risk—any weekly return, $w_{i,\tau}$, that is less than 3.2 standard deviation of its mean in a given year, the value of one will be assigned to this dummy variable and zero otherwise.

2.2 Cash holding

According to General theory (Keynes, 1936), there are three main reasons for the firm to conserve cash including transaction purpose, precautionary purpose, and speculative purpose[3]. So, targeting the level of cash holding is one of the important corporate decisions. Based on transaction motive, a firm requires to optimally hold cash to match with its daily operation. Also, a firm needs cash to secure future investment due to speculative motivation. Lastly, based on precautionary motivation, holding cash is widely recognized for reducing risk from cash flow variation (Campello, 2003; Morris, 1983; Opler, Pinkowitz, Stulz, & Williamson, 1999). Furthermore, companies can strategically avoid extreme losses by holding excessive cash (Hambrick and Finkelstein, 1987).

However, the impact of cash holding on firm's risk is unclear. Unlike General theory, the more recent research finds that firms hold excessive cash due to agency motive. For example, Jensen and Meckling (1976) suggest that firms with excessive cash holding are more prone to agency issues—e.g., an over investment problem. Furthermore, Jensen (1986) demonstrates that managers prefer to hold cash not only for traditional motivations but also for self-interest. They prefer to finance future investment with cash rather than with funds from an external source which will come with additional external monitoring. Further, Acharya et al. (2007) argue that managers prefer to hold cash to pay off existing debt from a risk hedging perspective. This cash hoarding increases as managers become more risk averse and asymmetric information increases within the firm. As a consequence, this higher leverage policy leads to an increase in extreme losses. In

[3] In the modern context, firm also needs cash as a part of the resource to perform CSR activities (Liang, Xue, & Zhang, 2023)

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

summary, based on agency motive, increasing cash holding leads to higher asymmetric information. Hence, in this study we hypothesize that the firm with larger cash holding faces more asymmetric information and hence an increase in crash risk.

In order to test our hypothesis, we apply two cash holding measures including the ratio of cash and equivalents to total assets (Hardin, Highfield, Hill, & Kelly, 2009; Ozkan & Ozkan, 2004) and the ratio of cash and marketable securities to total assets minus cash and marketable securities (Opler et al., 1999) as follow:

$$CASH1_{i,t} = \frac{Cash\ and\ equivalent}{Total\ assets} \tag{5}$$

$$CASH2_{i,t} = \frac{Cash\ and\ marketable\ securities}{Total\ assets\ minus\ cash\ and\ marketable\ securities} \tag{6}$$

2.3 Control variable

We include a number of control variables according to the prior literature. Firstly, we include $NSKEW_{i,t-1}$ to control for a possible serial correlation in skewness of return. Second, we include the volatility of return (SIGMA), as highly volatile stocks are more likely to exhibit the negative skewness in return and hence more likely to be exposed to crash risk. Third, large past returns (RET) would perhaps be built up, raising the possibility of a huge price drop later and past stock turnover (DTURN) shows disagreement among investors' viewpoints (Chen et al., 2001). Fourth, we control for firm size and firm growth opportunity as the logarithm of market capitalization (SIZE) and the market-to-book value ratio (MB) (Chen et al., 2001; Hutton et al., 2009). In addition, we also control for the external monitoring using the firm's leverage (LEV)(Almagribi, Lukviarman, & Setiany, 2023). As the ratio of total assets less stockholder equity to total assets increases, the external monitoring by debtholders increases. Therefore, the stock price crash risk is relatively low (Hutton et al., 2009). Besides, a large profitable firm is less likely to experience bad news hoarding behavior, subsequently showing a low crash risk (Chang, Chen, & Zolotoy, 2017; Hutton et al., 2009), the return on assets (ROA) is then included. Lastly, we add discretionary accruals (DACC) to control the possible effect of earnings management as suggested by Hutton et al. (2009). All variables definitions are defined in Appendix A.

3. DATA SELECTION AND METHODOLOGY

3.1 Data selection

We gather market data including stock price, market value, and risk free rate from Refinitiv Eikon and gather financial and accounting data from World Scope. Our primary sample includes all U.S. firms between 1991-2019. We exclude all incomplete data firms and the firms with negative book value of total assets. Also, we exclude financial service firms (SIC6000-6999) since financial service firms have a different accounting structure[4]. To alleviate a potential problem of extreme outliers, we winsorize all variables at the 1% and 99% percentiles. In summary, the sample includes 36,334 firm-year observations between 1991 and 2019, comprising 6,170 unique firms

[4] Another reason is suggested by Lee et al. (2020), who show that the financial service sector is heavily regulated, potentially causing less agency problem. Consequently, the financial service firms are less prone to crash risk.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

3.2 Empirical models

In order to validate our proposition, we propose the empirical model as:

$$CRASH_{i,t} = \alpha_i + \beta_i CASH_{i,t-1} + \gamma_i \sum_{i=1}^{k} CONTROL_{i,t-1} + Industry\ Fixed\ effect + Year\ Fixed\ Effect + \varepsilon_{i,t} \quad (7)$$

where $CRASH_{i,t}$ is three crash risk measures of firm i in year t that are the negative skewness measure ($NSKEW_{i,t}$), the down-to-up volatility ($DUVOL_{i,t}$), and ($ICRASH_{i,t}$), respectively. $CONTROL_{i,t-1}$ are control variables as mentioned in the previous section. To be more specific, we apply panel regression for NSKEW measure and DUVOL measure and we apply panel logistic regression for ICRASH measures—a binary outcome. To account for the possible effect of economic variation and industry specific effect on stock price crash risk, we include both year fixed effects and industry fixed effects in all models.

4. EMPIRICAL RESULT

4.1 Descriptive statistic

This section reports the sample descriptive statistic as shown in Table1. Panel A shows the descriptive statistic for stock price crash risk measures. The mean of three stock price crash risk measures are all positive indicating that half of the firms experienced stock price crash risk. Panel B shows descriptive statistic for independent variable used in this study, on average, U.S. firms hold 14.9% of cash to total assets and 21.1% of cash and short-term investments to total assets minus cash and marketable securities. Hence, it shows that companies hold liquidity in both cash and securities.

Table 2 shows pairwise correlation among all variables under study. All three stock price risk measures are positively correlated despite a small correlation between DUVOL and the other two crash risk measures—NSKEW and ICRASH.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 1: Descriptive statistics for all variables used in this study. Panel A presents the summary statistics for Crash risk measures. Panel B presents the summary statistics for independent variables. (All variables are defined as in Appendix A.).

Panel A: Crash risk measures									
	Mean	S.D.	Min	p25	p50	p75	Max	skewness	kurtosis
NSKEW	0.226	0.826	-1.549	-0.324	0.151	0.638	2.878	0.777	4.599
DUVOL	0.060	0.620	-1.132	-0.351	0.058	0.456	1.779	0.222	2.950
CRASH_Dummy	0.140	0.347	0.000	0.000	0.000	0.000	1.000	2.073	5.299
Panel B: Independent variables									
	Mean	S.D.	Min	p25	p50	p75	Max	skewness	kurtosis
CH2	0.149	0.184	0.000	0.023	0.079	0.199	0.866	2.027	7.176
CH4	0.211	0.245	0.001	0.029	0.106	0.308	0.939	1.425	4.110
TA	15.170	16.157	8.362	11.918	13.370	14.748	17.853	5.501	40.400
MB	2.889	4.002	0.000	1.200	1.930	3.380	20.430	3.000	22.217
ROA	-1.192	22.047	98.96	0.190	3.620	7.950	28.210	-3.321	17.263
DACC	-0.062	0.177	-0.682	-0.122	-0.046	0.010	0.467	-0.443	9.496
DTURN	5.727	81.989	-246.776	-20.305	1.061	26.761	304.229	0.694	9.655
LEV	0.613	0.369	0.055	0.366	0.591	0.829	2.066	2.186	14.330
SIGMA	0.049	0.035	0.000	0.025	0.042	0.067	0.159	0.966	3.990
RET	0.001	0.010	-0.034	-0.003	0.001	0.005	0.023	-0.954	5.942

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Table 2 demonstrates pairwise correlation for variables used in this study (All variables are defined as in Appendix A).

VAR	NSKEW	DUVOL	ICRASH	CH2	CH4	RET	SIGMA	SIZE	MB	ROA	DACC	DTURN	LEV
NSKEW	1.000												
DUVOL	0.475	1.000											
ICRASH	0.619	0.002	1.000										
CH2	0.155	0.064	0.124	1.000									
CH4	0.160	0070	0.131	0.767	1.000								
RET	0.230	0.011	-0.111	-0.019	-0.031	1.000							
SIGMA	0.388	0.051	0.361	0.189	0.219	-0.181	1.000						
SIZE	0.003	-0.008	-0.017	-0.227	-0.193	-0.034	-0.346	1.000					
MB	0.001	0.000	0.003	-0.006	0.002	0.007	-0.002	0.003	1.000				
ROA	-0.005	0.000	-0.005	-0.034	-0.026	-0.035	-0.029	0.038	0.002	1.000			
DACC	0.000	0.000	0.006	0.019	0.020	-0.010	0.045	-0.027	0.001	-0.038	1.000		
DTURN	0.017	-0.004	0.010	0.006	0.000	-0.032	0.085	-0.037	0.000	-0.001	0.003	1.000	
LEV	0.001	0.000	0.001	0.058	0.029	0.025	0.020	-0.046	-0.002	-0.311	0.003	0.000	1.000

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

4.2 Base line result

Table 3 reports the fixed effect panel regression obtained by Eq.4. Column 1 – 3 shows the results based on $CASH1$. The finding demonstrates the positive and significant association between cash holding and all stock price crash risk measures. Specifically, for NSKEW, the coefficient of $CASH1$ is 0.113 which means a one percent increasing in cash holding will increase stock price crash risk by 0.113%. [5] We find the same association with different magnitude for DUVOL. In the same way, the coefficient of ICRASH is positive. The positive sign for logistic regression means that, all else being unchanged, an increase in cash holding will increase the likelihood that firm will experience stock price crash risk in the future. Regarding the control variable, our findings are generally consistent with the prior studies (Hutton et al., 2009; J.-B. Kim, Li, & Zhang, 2011; J. B. Kim & Zhang, 2014; Wattanatorn & Padungsaksawasdi, 2022a, 2022b). To be more specific, we find that NSKEW is positive and significant in all models suggesting the potential serial correlation of firm specific skewness. SIGMA is all positive for all stock price crash risk measures signifying that firms with historically high volatility are more likely to experience stock price crash risk. In addition to firm's specific volatility, RET shows positive association with stock price crash risk. This finding is consistent with a stock price build up hypothesis. Although we cannot quantify the significant impact of BTMV and ROA on stock price crash risk, its positive signs are preserved in all models. In addition, we find SIZE, DTURN and LEV are all significant in most cases.

The columns 4-6 show the result based on $CASH2$. We find all results similar but of a different magnitude. To be more specific, a one percent increase in $CASH2$ leads to 0.096% increase in stock price crash risk which is lower than $CASH2$. We find the same result for DUVOL and ICRASH.

Table 3: Base line regression shows the effect of cash holding on stock price crash risk. NSKEW and DUVOL are negative skewness and down-to-up volatility defined by Eq.3 and Eq.4 respectively. $CASH1_{t-1}$ and $CASH2_{t-1}$ are our main interest variable formulated by Eq.5 and Eq.6 respectively. The panel fixed effect analysis is employed to examine the association between cash holding and NSKEW and DUVOL. For ICRASH which is a binary variable, the panel logistic regression is employed. All regressions include industry and yearly effect. t-statistics are reported in parentheses. *, **, and *** represent significant value at 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	NSKEW	DUVOL	ICRASH	NSKEW	DUVOL	ICRASH
$CASH1_{t-1}$	0.113**	0.0347**	0.191*			
	(2.14)	(2.11)	(1.71)			
$CASH2_{t-1}$				0.0962**	0.01818*	0.277***
				(2.34)	(1.83)	(4.30)
$NSKEW_{t-1}$	0.0699***	0.567***	0.0852***	0.0542***	0.575***	0.0983***

[5] In an unreported table, we include the effect of financial crisis during 2007 and 2008. The results are the same. We find that the coefficient of CASH1 increases to about 0.122 while the other variables remain unchanged.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

	(11.06)	(26.07)	(6.43)	(10.38)	(36.07)	(7.31)
$SIGMA_{t-1}$	1.351***	2.661***	1.723**	1.520***	2.651***	3.477***
	(6.13)	(38.58)	(2.25)	(8.60)	(47.27)	(2.65)
RET_{t-1}	6.697***	24.29***	13.85***	6.358***	23.32***	9.747*
	(9.96)	(15.56)	(2.91)	(12.01)	(13.89)	(1.72)
$SIZE_{t-1}$	0.159***	5.152**	0.193***	0.137***	0.891	0.00927
	(18.39)	(2.15)	(10.45)	(20.55)	(1.21)	(0.57)
MB_{t-1}	0.000379	0.130	0.000354	0.000879***	0.381	0.00164
	(0.11)	(0.14)	(0.05)	(0.34)	(0.57)	(0.13)
$DTURN_{t-1}$	0.0000384**	0.00227	0.0000638*	0.0000281**	0.00351	0.0000254
	(3.66)	(0.78)	(1.83)	(3.25)	(1.50)	(1.56)
LEV_{t-1}	0.00491	-0.159	0.0294*	-0.000202	-0.0548	-0.00104
	(1.56)	(-0.18)	(1.89)	(-0.20)	(-0.20)	(-0.72)
$DACC_{t-1}$	-0.00241	-0.0282	-0.00466	-0.00285	0.0556	-0.00758
	(-0.68)	(-0.03)	(-0.45)	(-0.85)	(0.08)	(-1.52)
ROA_{t-1}	-0.0000613	-0.00211	0.000224	-0.0000736*	-0.000474	-0.0000321
	(-1.22)	(-0.15)	(1.03)	(-1.66)	(-0.05)	(-0.30)
α	-0.637***	14.36		-0.466***	-2.282	-3.474***
	(-3.08)	(0.25)		(-3.27)	(-0.06)	(-5.20)
Adj-R2	3.09%	0.12%		2.96%	0.09%	
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes

5. ENDOGEINEITY: 2SLS

In order to take the endogeneity issue into account, we employ two stage least square (2SLS) which is widely used in economics and finance to assess the impact of corporate cash holding and stock price crash risk. In the first stage, we employ Opler et al. (1999) model to estimate cash holding together with the control variables as shown in Eq.4 as follow:

$$CASH_{i,t} = \alpha_i + \beta_i CASH_{i,t-1} + \pi_i \sum_{i=1}^{k} CASH\ CONTROL_{i,t-1} + \\ + Industry\ Fixed\ effect + Year\ Fixed\ Effect + \varepsilon_{i,t} \quad (6)$$

where $CASH_{i,t-1}$ is the CASH measure of firm i in year $t-1$ and $CASH\ CONTROL_{i,t-1}$ are Market to book ratio, Firm size—logarithm of book value of total assets, Cash flow to total assets—Earnings after interest, dividend, and taxes but before depreciation to total

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

assets, Networking capital to total assets—the difference between current assets and current liabilities minus cash to total assets, Capex to total assets, Leverage to total assets—short and long term debt to total assets, Research and development expense to Revenues, dividend dummy—dummy is one in the year that firm pays dividend and zero otherwise. In the second stage, we regress crash risk measures on the predicted cash holding as in Eq.4. Also, we include year fixed effect and industry fixed effect to account for economic variation and industry specific condition. The result of 2SLS is reported in Table 4.

Table 4 performs 2 stages least square (2SLS) and demonstrates the effect of cash holding on stock price crash risk. NSKEW and DUVOL are negative skewness and down-to-up volatility defined by Eq.3 and Eq.4 respectively. $CASH1_{t-1}$ and $CASH2_{t-1}$ are our main interest variable formulated by Eq.5 and Eq.6 respectively. The panel fixed effect analysis is employed to examine the association between cash holding and NSKEW and DUVOL. For ICRASH which is a binary variable, the panel logistic regression is employed. All regressions include industry and yearly effect. t-statistics are reported in parentheses. *, **, and *** represent significant value at 10%, 5%, and 1% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)
	NSKEW	DUVOL	ICRASH	NSKEW	DUVOL	ICRASH
$\widehat{CASH1}_{t-1}$	0.346*	0.1432*	1.128***			
	(1.65)	(1.94)	(3.21)			
$\widehat{CASH2}_{t-1}$				0.275***	0.0463*	0.203**
				(4.22)	(1.93)	(2.19)
$NSKEW_{t-1}$	0.0851***	0.559***	0.0431**	0.0192***	0.562***	0.0231
	(8.82)	(180.19)	(2.13)	(2.58)	(230.89)	(1.04)
$SIGMA_{t-1}$	1.418***	2.832***	2.351***	2.249***	2.596***	2.450***
	(4.15)	(25.81)	(3.98)	(9.94)	(33.50)	(4.30)
RET_{t-1}	6.826***	25.03***	5.612***	3.934***	24.34***	4.977***
	(6.86)	(78.35)	(2.97)	(5.59)	(106.09)	(2.62)
$SIZE_{t-1}$	0.158***	0.111***	0.00841	0.0241***	0.0230***	0.0103
	(12.14)	(13.91)	(0.86)	(6.51)	(10.12)	(0.81)
MB_{t-1}	0.00872	0.00441	0.0969***	0.0165***	0.0120***	0.0457
	(1.15)	(0.95)	(3.32)	(3.18)	(3.73)	(1.37)
$DTURN_{t-1}$	0.000109***	0.0000917***	0.000192***	0.0000202	0.0000181**	0.0000396
	(3.77)	(5.19)	(2.62)	(1.51)	(2.18)	(1.11)
LEV_{t-1}	0.00911	0.00787	-0.0117	0.00537	0.00304	-0.0194
	(0.86)	(1.22)	(-0.39)	(0.69)	(0.63)	(-1.12)
$DACC_{t-1}$	0.00157	0.00140	0.00421	0.000105	0.000365	0.00296
	(0.32)	(0.47)	(0.48)	(0.03)	(0.18)	(0.79)
ROA_{t-1}	-0.0000180	-0.0000129	0.000340	-0.0000106	-0.0000108	0.000296

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

	(-0.33)	(-0.39)	(1.21)	(-0.24)	(-0.41)	(1.62)
α	-0.664***	-0.585***	-1.827***	-0.116*	-0.160***	-1.728***
	(-5.78)	(-8.31)	(-2.83)	(-1.67)	(-3.75)	(-6.80)
Adj-R2	3.58%	3.91%		3.11%	3.04%	
Industry Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes

The results shown are consistent with the prior section. We find that an increase in cash holding can increase stock price crash risk. In addition, we find that both NSKEW and DUVOL show positive association with stock price crash risk. Also, the coefficient of ICRASH suggests that an increasing corporate cash holding increases the probability for the firm to experience stock price crash in the subsequent year. All the control variables are similar to prior section.

6. ROBUSTNESS TEST: FIRM FIXED EFFECT

In this section, we enhance the robustness of our results by including firm fixed effect to alleviate model bias from omitted variable, though we include most of control variables in our model. Lee et al. (2020) suggest that firm fixed effect could alleviate the omitted variable bias since the firm fixed effect can control for unobservable firm specific characteristics that variate over time within firms. We then report the result in Table 5

Table 5 performs firm-fixed effect regression and demonstrates the effect of cash holding on stock price crash risk. NSKEW and DUVOL are negative skewness and down-to-up volatility defined by Eq.3 and Eq.4 respectively. $CASH1_{t-1}$ and $CASH2_{t-1}$ are our main interest variable formulated by Eq.5 and Eq.6 respectively. The panel fixed effect analysis is employed to examine the association between cash holding and NSKEW and DUVOL. For ICRASH which is a binary variable, the panel logistic regression is employed. All regressions include industry and yearly effect. t-statistics are reported in parentheses. *, **, and *** represent significant value at 10%, 5%, and 1% levels, respectively

	(1)	(2)	(3)	(4)	(5)	(6)
	NSKEW	DUVOL	ICRASH	NSKEW	DUVOL	ICRASH
$CASH1_{t-1}$	0.113**	0.0319**	0.213**			
	(2.12)	(2.16)	(2.16)			
$CASH2_{t-1}$				0.147***	0.0727***	0.156*
				(3.57)	(4.71)	(1.84)
$NSKEW_{t-1}$	0.0699***	0.610***	0.0722***	0.0554***	0.619***	0.0589***
	(9.01)	(7.54)	(4.84)	(10.62)	(3.48)	(5.33)
$SIGMA_{t-1}$	1.351***	4.683***	0.510	1.843***	4.704***	0.739**
	(4.21)	(19.18)	(0.90)	(11.08)	(17.74)	(2.09)

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

RET_{t-1}	6.697***	44.59***	12.22***	3.944***	45.14***	7.339***
	(8.27)	(16.14)	(6.72)	(8.22)	(18.00)	(7.04)
$SIZE_{t-1}$	0.159***	0.0925***	0.258***	0.0913***	0.0836***	0.191***
	(13.97)	(3.51)	(10.42)	(15.72)	(4.67)	(14.62)
MB_{t-1}	0.000379	0.00254	0.00231	0.0112***	0.00394*	0.0159***
	(0.09)	(1.00)	(0.27)	(4.22)	(1.97)	(2.67)
$DTURN_{t-1}$	0.0000384*	0.0000106***	0.0000887*	0.0000231***	0.00000587*	0.0000477**
	(1.68)	(2.72)	(1.85)	(2.65)	(1.80)	(2.52)
LEV_{t-1}	0.00491	-0.00160	0.0349	-0.0000506	-0.000170	-0.000683
	(1.52)	(-1.37)	(1.61)	(-0.05)	(-0.45)	(-0.32)
$DACC_{t-1}$	-0.00241	-0.000255	-0.00811	-0.00260	-0.000853	-0.00676
	(-0.78)	(-0.19)	(-0.80)	(-0.77)	(-0.68)	(-0.73)
ROA_{t-1}	-0.0000613	-0.00000499	0.000266	-0.0000676	0.000000532	-0.0000777
	(-0.96)	(-0.27)	(1.16)	(-1.51)	(0.03)	(-0.57)
α	-1.232***	-0.908***	-3.783***	-0.398***	-0.854***	
	(-7.66)	(-45.72)	(-6.43)	(-9.37)	(-56.00)	
Adj-R2	11.2%	34.7%		10.2%	34.3%	
Firm Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes
Year Fixed Effect	Yes	Yes	Yes	Yes	Yes	Yes

Controlling for firm fixed effect, Table 5 shows the consistent result with prior section. We find that $CASH1$ and $CASH2$ can positively predict the future stock price crash risk for all stock price crash risk measures. This supports that our findings are less likely to be impacted by omitted firm characteristics.

7. CONCLUSION

This study sheds light on the association between corporate cash holding and stock price crash risk. Based on agency motives, the firms holding excessive cash are more likely to face agency problems and subsequent asymmetric information issues. Therefore, we apply the level of cash holding to proxy for firm's asymmetric information, indicting that firms with more cash holding are more prone to stock price crash risk. Based on our U.S. sample between 1990 and 2019, the results underscore the role of cash holding in stock price crash risk. We find a positive association between cash holding and stock price crash risk. This implies that the higher level of cash holding heightens stock price crash risk. Our findings are in the line with the agency-conflict motive.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

Appendix A. Variable definitions

Variable	Definition
$NSKEW$	Negative skewness of the firm specific weekly return
$DUVOL$	The logarithm of the ratio of down-to-up volatility of the firm specific weekly return
$ICRASH$	Dummy of crash risk. It will be 1 if we observe at least one crash week during a year, and 0 otherwise.
$CASH1$	Cash holding measure according to Hardin et al. (2009) and Ozkan and Ozkan (2004)
$CASH2$	Cash holding measure according to Opler et al. (1999)
$SIGMA$	The standard deviation of firm specific weekly return
RET	The firm specific weekly return
$SIZE$	The logarithm of market capitalization
MB	The ratio of market value of equity to the book value of equity
$DTURN$	The average monthly stock turnover in year t minus the average monthly stock turnover
LEV	The ratio of total assets less stockholder equity to total assets.
$DACC$	The three-year moving sum of the absolute value of annual discretionary accruals. Hutton et al. (2009)
ROA	The return on assets

REFERENCES

[1] Acharya, V. V., Almeida, H., & Campello, M. (2007). Is cash negative debt? A hedging perspective on corporate financial policies. *Journal of financial intermediation, 16*(4), 515-554.

[2] Almagribi, M. K., Lukviarman, N., & Setiany, E. (2023). Financial Determinants of Corporate Cash Holdings: Evidence from Property and Real Estate Companies in Indonesia. *Review of Integrative Business and Economics Research, 12*(3), 251-260.

[3] Bollerslev, T., Todorov, V., & Xu, L. (2015). Tail risk premia and return predictability. *Journal of Financial Economics, 118*(1), 113-134.

[4] Campello, M. (2003). Capital structure and product markets interactions: evidence from business cycles. *Journal of Financial Economics, 68*(3), 353-378.

[5] Chang, X., Chen, Y., & Zolotoy, L. (2017). Stock liquidity and stock price crash risk. *Journal of financial and Quantitative Analysis, 52*(4), 1605-1637.

[6] Hambrick, D. C., & Finkelstein, S. (1987). Managerial discretion: A bridge between polar views of organizational outcomes. *Research in organizational behavior*.

[7] Hardin, W. G., Highfield, M. J., Hill, M. D., & Kelly, G. W. (2009). The determinants of REIT cash holdings. *The Journal of Real Estate Finance and Economics, 39*(1), 39-57.

[8] Hutton, A. P., Marcus, A. J., & Tehranian, H. (2009). Opaque financial reports, R2, and crash risk. *Journal of Financial Economics, 94*(1), 67-86.

[9] Jensen, M. C. (1986). Agency costs of free cash flow, corporate finance, and takeovers. *The American economic review, 76*(2), 323-329.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)

[10] Jensen, M. C., & Meckling, W. H. (1976). Theory of the firm: Managerial behavior, agency costs and ownership structure. *Journal of Financial Economics, 3*(4), 305-360.
[11] Kelly, B., & Jiang, H. (2014). Tail Risk and Asset Prices. *The Review of Financial Studies, 27*(10), 2841-2871. doi:10.1093/rfs/hhu039
[12] Keynes, J. M., & Waeger, F. (1936). *Allgemeine Theorie der Beschäftigung, des Zinses und des Geldes* (Vol. 6): Duncker & Humblot Berlin.
[13] Kim, J.-B., Li, Y., & Zhang, L. (2011). CFOs versus CEOs: Equity incentives and crashes. *Journal of Financial Economics, 101*(3), 713-730.
[14] Kim, J. B., & Zhang, L. (2014). Financial reporting opacity and expected crash risk: Evidence from implied volatility smirks. *Contemporary Accounting Research, 31*(3), 851-875.
[15] Lee, S. M., Jiraporn, P., & Song, H. (2020). Customer concentration and stock price crash risk. *Journal of Business Research, 110*, 327-346.
[16] Liang, Y., Xue, C., & Zhang, J. (2023). The impact of ESG ratings on stock liquidity risk: Evidence from the Chinese market. *Review of Integrative Business and Economics Research, 12*(4), 1-16.
[17] Morris, J. R. (1983). The role of cash balances in firm valuation. *Journal of financial and Quantitative Analysis*, 533-545.
[18] Opler, T., Pinkowitz, L., Stulz, R., & Williamson, R. (1999). The determinants and implications of corporate cash holdings. *Journal of Financial Economics, 52*(1), 3-46.
[19] Ozkan, A., & Ozkan, N. (2004). Corporate cash holdings: An empirical investigation of UK companies. *Journal of Banking & Finance, 28*(9), 2103-2134.
[20] Wattanatorn, W., & Padungsaksawasdi, C. (2022a). The board effectiveness index and stock price crash risk. *Managerial finance, 48*(1), 126-135. doi:10.1108/MF-04-2021-0150
[21] Wattanatorn, W., & Padungsaksawasdi, C. (2022b). Stock price crash risk: the role of systematic skewness. *International Journal of Monetary Economics and Finance, 15*(1), 78-93. doi:10.1504/IJMEF.2022.121561
[22] Xu, N., Jiang, X., Chan, K. C., & Yi, Z. (2013). Analyst coverage, optimism, and stock price crash risk: Evidence from China. *Pacific-Basin Finance Journal, 25*, 217-239.

ISSN: 2304-1013 (Online); 2304-1269 (CDROM); 2414-6722 (Print)