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RESEARCH PAPER

# Impact of Cash Flow Uncertainty, Financial Constraints and Accounting Opacity on Cash Holding

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**ABSTRACT**

This study explores the effect of cashflow uncertainty, accounting opacity and financial constraints on corporate cash holdings in non-financial sector of Pakistan. Prior research suggests that firms hold cash for precautionary and transactional motives, yet excessive reserves can lead to agency problems and opportunity cost. Using data from 72 non-financial firm listed on Pakistan Stock Exchange KSE-100 index during 2013-2022, financial data was extracted from the annual reports. Our findings reveals that uncertainty in cash flow positively effect on company's cash holding. Also, financial constraints have negative impact on cash holdings. Also, size have a significant and negative impact on cash holdings. Likewise, accounting opacity demonstrates a negative effect on cash of holdings. It is highlighted that firm size plays moderating role between all these determinants and cash reserves. The finding of this study contributes valuable insight for policymakers, investors and managers in emerging economies and understanding the concept of cash management practices in emerging markets.

**KEYWORDS** Cash Flow Uncertainty, Financial Constraints, Accounting Opacity, Cash Holding

## Introduction

There is increasing data due to current period corporation have activated to want to increase their cash holding. According to Amess et.al; (2015), that cash holding increasing is globally occurrence. In past from 1990s to 2000s US represent their GDP is 10% and US firms increase their cash holding by annually an average of 0.46% (Bates, Kahle and Stulz, 2009). Another countries like Japan and South Korea are cash holding 44% and 34% of their GDPs respectively. According to Chen et al. (2012) explain that China, Taiwan, Europe and Mainland introduce inclination of increasing cash holding. Kuan et al. (2012) explain that In Taiwan listed firms increase average level of cash holding. Opportunities cost generates when cash holding increase. Bates et al. (2009) explain that increasing cash holdings mostly initiate from those firms which hold some portion of cash against cash flow uncertainty. If a firm want to make some investment plain but if they have no cash available for investment in which this situation firm lose investment opportunities then they face underinvestment problems. According to this situation a firm have must some optimal level of cash holdings at any time then they easily make good investment opportunities. When a firm has suitable level of cash then they increase value of firm. Recent studies show that since 2000 increase trend of cash holding (Legesse et al., 2023; Liu et al., 2023; Tran et al., 2024; Sánchez & Yurdagul, 2013). If firm want to increase their high level of growth and high level of investment then they increase their cash holding level (Opler, et al.,1999; Legesse et al., 2023; Liu et al., 2023;

Tran et al., 2024). Financial position of most of the company is comprehensive. In previous study represent that most of the company generated their funds form operation and then grow at an average rate of annual basis is 29% rate according to previous 3 years. According to previous studies explain that in company's history self-financing concepts do not control for the growth of the company (Hewlett-Packard 1982).

**Literature Review**

Holding cash is an important decision of companies. Some companies have huge portions of cash reserves, and some companies have problems of cash to manage operational expenses. We use cash for many purpose. Companies have must decide how to preserve their earning for future savings plain and how earnings should be used for pay dividend to shareholders (Lin et al., 2017). Existing literature had focus on factored that effect on cash holding. In which is precautionary motive, agency problems of managers, misuse of cash (Amess et al., 2015; Ejaz et al., 2022; Fayyaz et al., 2023; Gryko et al., 2024;Jalal et al., 2016; Jin & Marshall, 2024;). Financial manager of companies have need cash for meet some expenses like pay to labor, buy raw material, pay dividend and all other important expenses is due to meet in within in range. Cash is very important element in business if a firm have no cash then how they meet their expenses and how they can develop their growth in market. According to perfect market in which a firm has no reason to hold cash but if firm want to invest then it can find the deposit in the market at a cost is the purpose of risk and success of projects. According to imperfect market internal and external funds are no longer in perfect alternates then many theoretical models suggest the motives of corporate cash holdings. Previous study explains that transaction cost is main factor of cash if firm have higher marginal cost for cash then they hold more cash.

Cash flow uncertainty is one of the main factors affect firm cash flow Sánchez et al. (2013). The existing literature discusses many factors in cash flow uncertainty. Researchers present different factor in which cash flow uncertainty is directly or indirectly related the firm productivity. Firm is suffering with high cash flow uncertainty if dividends due to cash shortfalls. Normally external financing is too expensive as compare form internal financing they have unpredictable cash flow. According to Chay and Suh (2009) presented that dividend policy. In which they relate cash flow uncertainty and discuss factors effect on dividend policy. Cash flow uncertainty is strongly effect on dividend policy as compared to other potential determinant like capital mix, agency conflict and investment(Wang, 2010). If firm have low level of cash holding then they invest low due to increase in cash flow uncertainty(Faulkender & Wang, 2006; Ferreira et al., 2004).

Previous study explains that when industry faces more risk than they can hold more cash. Bao et al. (2012) show that empirical study explains that corporate cash holding display an irregular understanding to cash flows. Further study explains that company's cash holding and company's cash flow show negative relationship. Researcher's further divided companies in two parts negative and positive earnings. When company has positive earning then they focus on increase their investment projects and want to invest more and more to earn maximum profit and enhance company condition in good way but in this situation company reduce their cash holding process due to money invest in new projects. When companies earning in negative way then they do not want to invest more than company hold more cash and reduce their investment process.

H1: Precautionary motive support that cash flow uncertainty positively effect on company's cash holding.

It is define that "constraints In terms of the section between firms opportunities cost of internal capital and its cost of external capital." Financial constraints are very important element of firm behavior (Almeida et al., 2004). Previous theories prove that firm can suffer with financial issues which force it to complete the project (Tirole, 2006).He also explain that lender has a power to invest when the business take the borrow that make possible to increase the investment.

According to above discussion we formulate following hypothesis

H3: financially constrained firms increase cash holdings in reaction to increase in cash flow volatility.

Accounting accruals is the basic accounting source that is required to organize revenue and cost they can check that at what time benefits and cash is received or not. Managers of firm generally use this source to check and balance the performance of firm (Dechow & Skinner, 2000; Dechow & Dichev, 2002; Dechow et al., 2011). Accruals basically not interfere in operation of business it's performing as e accounting methods to use for different activities in the firm. Managers of firm mostly use accounting accruals as e important power to control profits of firms in different periods of firm's situation.

Current financial situation according to financial societies and many researchers has been focus on earnings management (Shivakumar, 2000; Shrieves & Gao, 2002; Sun, 2012, Teoh et al., 1998). Earning management is a joint wonder in traded firms. Earning management is basically managing accounting tools of any firms and manages financial reports and present performance of firms then they satisfy company's shareholders and its creditors. Pornsit et al. 2008, explain that generally Accepted Accounting Principles (GAAP) provides opportunities to manager then they manage their firm earning and increase firm wealth. If companies have potential to use their earning in smooth way then they increase their prices of shares and increase companies' wealth (Erickson & Wang 1999). Earnings management check firms earnings and confirm that financial statement is in better look.( Shivakumar, 2000; Shrieves & Gao, 2002; Sun, 2012, Teoh et al., 1998). Healy and Helen, 1999 explain that earning management is good for firm they use earning management techniques and improve financial position of firms.

Previous study Arya, Glover, and Sunder (2003) explain that smooth earnings remove for temporary portion earnings and communicate the stable portion. Chaney and Lewis (1995) explain that smooth earnings play important role and high valued as compare from low valued firms that smooth income. Demski (1998) suggest that harding working manger is efficient to predict future earning and manage financial statement on the other hand studies explain that smooth earning is better predict future earnings.

H4: Earnings quality has a negative impact on the level of cash holdings.

**Material and Methods**

In this study we collect the data from non-financial firms listed in KSE-100 index for time period 2013-2023. We take the financial reports from websites of sample companies. We also take the data from financial statements of these companies.

The focus of this study to check companies' cash holding behavior. In previous study mostly check financial constraints impact on cash holding. In this research paper checks impact of cash flow uncertainty, financial constraints and accruals on Cash holding. Financial constraints are second independent variables in which we use Age, size, dividend and KZ- index are use in this study. Accounting opacity is third variables use in this study. Following is the models of our study

1. $$CH_{it} = \beta_o + \beta_1 CFUNC_{it} + \beta_2 LEVERAGE_{it} + \beta_3 ROA_{it} + \beta_4 MTB_{it} + \beta_4 E_{i,t}$$

2. $$CH_{it} = \beta_o + \beta_1 FC(KZ)_{it} + \beta_2 LEVERAGE_{it} + \beta_3 ROA_{it} + \beta_4 MTB_{it} + \beta_4 E_{i,t}$$

3. $$CH_{it} = \beta_o + \beta_1 FC(SIZE)_{it} + \beta_2 LEVERAGE_{it} + \beta_3 ROA_{it} + \beta_4 MTB_{it} + \beta_4 E_{i,t}$$

4. $$CH_{it} = \beta_o + \beta_1 FC(DIVPAY)_{it} + \beta_2 LEVERAGE_{it} + \beta_3 ROA_{it} + \beta_4 MTB_{it} + \beta_4 E_{i,t}$$

5. $$CH_{it} = \beta_o + \beta_1 FC(AGE)_{it} + \beta_2 LEVERAGE_{it} + \beta_3 ROA_{it} + \beta_4 MTB_{it} + \beta_4 E_{i,t}$$

6. $$CH_{it} = \beta_o + \beta_1 ACOP_{it} + \beta_2 LEVERAGE_{it} + \beta_3 ROA_{it} + \beta_4 MTB_{it} + \beta_4 E_{i,t}$$

Where CH represent cash holding and i and t is firm and time. CFUNC represent cash flow uncertainty, ROA is return on assets. MTB represent firm growth, FC is financial constraints, and KZ is kz index use to measure financial constraints measures. DIVPAY represent dividend payment, ACOP represent Accounting Opacity and E is represent error term.

**Results and Discussion**

The results of table 4 descriptive statistics indicate that The mean value of cash holding is 0.124 and median value is 0.014, maximum value upto 6.06 and minimum is below 2.71 the standard deviation of CH is 0.50%. CH is positively skewed form 8.29 and from 82.028 kurtosis its means CH is peaked. The average value of size is 22.707 and median is 23.46. Standard deviation of size is 3.34%. Size is negatively skewed and it has 5.598 kurtosis its mean Size is peaked. Mean value of DIVIDED is 2.11 and its median is 2.79. standard deviation value of dividend 4.72%. DIVIDEND is positively skewed and it has 20.86 kurtosis its mean DIVIDEND show peaked. COMPANY AGE average value is 46.90 and its median is 36.00. COMPANY AGE show standard deviation is 33.56%. COMPANY AGE show positively skewed and its kurtosis value is 9.90 its mean COMPANY AGE is on peaked condition. The average value of ACCRUALS is 6.84 and median is 2.07. High value of ACCURALS is 1.73 and low value is -1.07. ACCRUALS is positively skewed and its kurtosis is 46.72 is greater than 3 its means ARRUALS is very peaked. it is very highly peaked. The mean value of LEVERAGE is 54.64 and median value of Leverage is 0.37. Maximum value of LEVERAGE is 5065.176 LEVERAGE is positively skewed and it has 151.83 kurtosis that why Leverage is peaked condition. Return on assets show average value is 0.816 and its median is 0.1018. The max. value is 197.27 and min. is -0.8482. SD of ROA 1.16%. It is positively skewed and from 299.93 kurtosis its mean ROA is peaked. SD-CFUNC is cash flow uncertainty its mean value is 1.33 and its median value is 1.17. ROA is maximum is 5.87 and minimum value is 0. Standard deviation of ROA is 5.46. ROA is positively skewed and its has kurtosis is 60.148 its mean ROA is high.

**Table 1**
**Descriptive Statistic**

| | Observations | Mean | Median | Std. Dev. | Maximum | Minimum | Skewness | Kurtosis |
|---|---|---|---|---|---|---|---|---|
| CH | 566 | 0.124349 | 0.014909 | 0.505659 | 6.060892 | 2.71E-07 | 8.292976 | 82.02826 |
| SIZE | 566 | 22.70795 | 23.46086 | 3.345918 | 27.16467 | 9.679969 | -1.742343 | 5.598058 |
| DIVIDEND | 566 | 2.11E+09 | 2.79E+08 | 4.72E+09 | 3.80E+10 | 0.000000 | 3.866503 | 20.86907 |
| COMPAGE | 566 | 46.90459 | 36.00000 | 33.56048 | 211.0000 | 6.000000 | 2.258408 | 9.909227 |
| ACCRUAL | 566 | 6.84E+09 | 2.07E+09 | 1.63E+10 | 1.73E+11 | -1.07E+10 | 5.917106 | 46.72732 |

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| MTB_RATIO | 566 | 4.280558 | 2.200000 | 9.087687 | 123.5000 | 0.000000 | 8.308127 | 93.03339 |
| LEVERAGE | 566 | 54.64159 | 0.373561 | 345.3558 | 5065.176 | 0.000000 | 11.35592 | 151.8373 |
| ROA | 566 | 0.816876 | 0.101857 | 10.16201 | 197.2738 | -0.848209 | 16.88377 | 299.9344 |
| SD_CFUNC | 566 | 1.33E+10 | 1.17E+09 | 5.46E+10 | 5.87E+11 | 0.000000 | 7.134210 | 60.14816 |

CH= cash holding calculates using cash equivalent and cash to Total Assets; SIZE = is calculating the natural logarithm of total assets; DIVIDEND= is taking value from annual reports of companies in which year company is paid total dividend; COMPANY AGE= in which year company is incorporated; ACCRUAL= is calculating using formula earning after extra-ordinary item+Depreciation-Cash flow from Operations to Total assets; MTB= is calculating using market to book value ratio; LEVERAGE= is calculating using formula total liabilities to market value of equity; ROA= is calculating using EBIT to Total Assets; SD-CFUNC is calculating through standard deviation of cash flow operation previous three years.

Table show that SD-CFUNC is also negatively correlated with CH and KZ-INDEX, (r = -0.046238 and r = -0.284010).Further table show control variables like MTB-RATIO is negatively correlated with CH and KZ-INDEX, (r = -0.043940 and r = -0.074533). LEVERAGE is also negatively correlated with CH and K-INDEX, (r = -0.018813 and r = -0.021134). ROA is positively correlated with CH and KZ_INDEX, (r = 0.010185 and r = 0.024288).

**Table 2**
**Correlation Analysis**

| | CH | KZ_INDE | SIZE | DIVIDEN | COMPANYA | ACCRUA | MTB_RAT | LEVERAC | ROA | SD_CFUN |
|---|---|---|---|---|---|---|---|---|---|---|
| **CH** | 1 | | | | | | | | | |
| **KZ_INDE** | 0.0306 | 1 | | | | | | | | |
| **SIZE** | -0.0957 | -0.3306 | 1 | | | | | | | |
| **DIVIDEN** | -0.0358 | -0.9232 | 0.3421 | 1 | | | | | | |
| **COMP AC** | 0.0023 | -0.0320 | 0.1437 | 0.01971 | 1 | | | | | |
| **ACCRUA** | -0.0262 | -0.8074 | 0.3374 | 0.86555 | 0.048071 | 1 | | | | |
| **MTB_RAT** | -0.0439 | -0.0745 | -0.0500 | 0.09481 | 0.017317 | 0.00253 | 1 | | | |
| **LEVERAC** | -0.0188 | -0.0211 | 0.0758 | 0.02151 | -0.045691 | -0.01009 | -0.048005 | 1 | | |
| **ROA** | 0.0101 | 0.0242 | -0.1275 | -0.02211 | -0.035085 | -0.01397 | -0.023329 | -0.01124 | 1 | |
| **SD_CFUN** | -0.04 | -0.28 | 0.04 | 0.02 | 0.029323 | 0.03 | -0.03 | -0.00 | -0.01 | |

CH= cash holding calculates using cash and cash equivalent to total assets; Kz-Index= is kz index is measurement of financial constraints calculates using $KZ = (-1.002)CASHFLOW + (0.283)Q + (3.139)LEVERAGE - (39.368)DIVIDENDS - (1.315)CASH$; SIZE = is calculating the natural logarithm of total assets; DIVIDEND= is taking value from annual reports of companies in which year company is paid total dividend; COMPANY AGE= in which year company is incorporated; ACCRUAL= is calculating using formula earning after extra-ordinary item+Depreciation-Cash flow from Operations to Total assets; MTB= is calculating using market to book value ratio; LEVERAGE= is calculating using formula total liabilities to market value of equity; ROA= is calculating using EBIT to Total Assets; SD-CFUNC is calculating through standard deviation of cash flow operation previous three years.

**Table 3**
**Impact of cash flow uncertainty, Financial Constraints on Cash holding**

| Dependent variable : Cash Holding | Model 1 | Model 2 | Model 3 |
|---|---|---|---|
| C | 0.0030*** | 0.0300*** | 0.00400*** |
| | (0.047398) | (0.123178) | (0.307173) |
| CFUNC | 0.0000*** | | |
| | (0.002878) | | |
| KZ-INDEX | | 0.0088** | |
| | | (-1.08E-14) | |

| | | | |
|---|---|---|---|
| SIZE | | | 0.0000*** |
| | | | (-0.008075) |
| ***Control Variables:*** | | | |
| Leverage | 0.0631 | 0.7523 | 0.7633 |
| | (3.04E-05) | (-1.01E-06) | (-1.37E-06) |
| ROA | 0.0000 | 0.0022 | 0.8716 |
| | (0.013253) | (0.000314) | (-3.58E-05) |
| MTB-RATIO | 0.0642 | 0.7336 | 0.0029 |
| | (0.000102) | (-2.07E-05) | (0.000150) |
| Adj. R-squared | 0.778978 | 0.721544 | 0.687349 |
| F-statistic | 21.20683 | 20.78440 | 17.78548 |
| Durban Watson stat | 2.003893 | 1.699997 | 1.769182 |

CH= cash holding calculates using cash and cash equivalent to total assets; Kz-Index= is kz index is measurement of financial constraints calculates using KZ = (-1.002) CF + (0.283)Q + (3.139)LEVERAGE – (39.368) D – (1.315) C; SIZE = is calculating the natural logarithm of total assets; MTB= is calculating using market to book value ; LEVERAGE= is calculating using formula total liabilities to market equity; ROA= is calculating using EBIT to Total Assets; SD-CFUNC is calculating through standard deviation of cash flow operation previous three years.

The table explores the main impact of cash flow uncertainty and financial constraints on cash holding. The results of this study support our first hypothesis **(H1)** is that CF uncertainty has positively impact on cash holding (Lin et al., 2017). Different accounting variables used to construct KZ model. The construction of KZ model discussed in the methodology of (Kaplan & Zingales 1997). All the firms have financial constraints when the KZ index is high. In this study KZ index is used as e continuous variables. The results of the coefficient in Model 2 shows that KZ-Index is significant but negatively associated with CH. In Model 3 also explain the effect of financial constraints on CH. In this SIZE is second proxy of measurement of financial constraints. The results of Model 3 also represent that SIZE is negative and significant effect on cash flow uncertainty.

The control variables use in this research paper Leverage, ROA, MTB ratio. The results of Table 3 show that in Model 1 Leverage is positive and significant associates with cash holding. In Model 2 Leverage is negative and insignificant associated with Cash holding. In Model 3 Leverage is negative and insignificant associated with Cash holding. Return on Assets ROA is second control variable use in this study. In Model 1 ROA are highly significant and positive associates with cash holding. In Model 2 ROA is positive and significant associated with cash holding. In Model 3 ROA are negative and insignificant associates with Cash holding (Jamil et. al., 2016). MTB ratio is third control variables used in this research papers. In Model 1 MTB ratio is positive and significant associated with CH (Afza & Adnan (2007). In Model 2 show that MTB ratio is negative and Insignificant associated with CH. In Model 3 MTB ratio is positive and significant associated with CH. The Durban-Watson test range given in all three Models which indicate here is no correlation.

**Table 4**
**Impact of Financial Constraints and Accounting Opacity on Cash holding**

| **Dependent variable : Cash Holding** | **Model 4** | **Model 5** | **Model 6** |
|---|---|---|---|
| C | 0.0000 | 0.0000 | 0.0000 |
| | (0.120191) | (0.198649) | (0.107502) |
| DIVIDEND | 0.0038 | | |
| | (-9.94E-13) | | |
| COMPANY AGE | | 0.0000 | |

| | | | |
|---|---|---|---|
| | | (-0.001601) | |
| ACCRUALS | | | 0.2078 |
| | | | (-1.30E-13) |
| ***Control Variables:*** | | | |
| Leverage | 0.9194 | 0.4784 | 0.2378 |
| | (-4.81E-07) | (-3.77E-06) | (2.76E-05) |
| ROA | 0.0111 | 0.2861 | 0.0000 |
| | (0.000425) | (0.000212) | (0.011796) |
| MTB-RATIO | 0.2260 | 0.0149 | 0.0829 |
| | (6.27E-05) | (0.000190) | (0.000102) |
| Adj. R-squared | 0.778396 | 0.691649 | 0.810444 |
| F-statistic | 24.44870 | 18.12601 | 25.11374 |
| Durban Watson stat | 1.767173 | 1.627479 | 2.137348 |

CH= cash holding calculates using cash and cash equivalent to total assets; DIVIDEND= is taking value from annual reports of companies in which year company is paid total dividend; COMPANY AGE= in which year company is incorporated; ACCRUAL= is calculating using formula earning after extra-ordinary item+Depreciation-Cash flow from Operations to Total assets; MTB= is calculating using market to book value ratio; LEVERAGE= is calculating using formula total liabilities to market value of equity; ROA= is calculating using EBIT to TA.

The above Table explores the impact of financial constraints and Accounting Opacity on Cash holding. In Model 4 Dividend is third variable for the measurement of financial constraints. CH represents cash holding it is dependent variable use in this study. In Model 4 Dividend is regress with CH. The results of Table 4.4 show that in Model 4 Dividend is negative and significant related with CH ( $\beta$ =0.0038, p> ) . In Table 5 Company Age is fourth variable for the measurement of financial constraints. In Model 5 show results that Age is negative and highly significant effect on CH ( $\beta$ =0.000,p> ). In Table 4.4 Model 6 show effects of Accounting Opacity on Cash holding. Accruals are proxy of Accounting Opacity. In Model 6 regress with Cash holding. Model 6 show that ACCRUALS show negative and insignificant effect on CH ( $\beta$ = 0.2078,p> ). These results accept our 3rd hypothesis (H3) that is Earnings has a negative impact on the level of CF. (Narciso, 2018).

The control variables use in this study is Leverage, ROA, MTB ratio. In Model 4 Leverage is negative and insignificant associated with CH. In Model 5 Leverage is negative and insignificant associated with CH. In Model 6 show that Leverage is positive and insignificant associated with CH. In Model 4 ROA is positive and significant associated with CH. In Model 5 ROA is positive and insignificant associated with CH. In Model 6 ROA is positive and significant associated with CH. MTB ratio is in Model 4 positive and insignificant related with CH. In Model 5 MTB ratio is positive and significant. Alam *et al.* (2011) In Model 6 MTB ratio is positive and significant related with CH Afza and Adnan (2007).

## Conclusion

The purpose of this study to explore the impact of uncertainty in cash flow, financial constraints and accounting opacity on cash holdings on Pakistani non-financial sector. Cash is most important factor in business activities. We meet all expenses through cash. The results of this research study are that cash flow uncertainty is main component

for increasing cash flow holdings. Results support our first hypothesis of this study is **($H_1$)** is that Precautionary motive is that cash flow uncertainty must positively effect on company's cash holding. Lin et. al. (2017) also support that cash flow uncertainty is main element for increasing cash holdings of firms. Iqbal (2017) also supports our first hypothesis. If firm have uncertainty situation then they want to save some portion of cash for avoid problems in business progress. If firm have low level of cash holdings, then they invest low dur to increase uncertainty. Cash flow uncertainty is the main portion of moving a firm cash holding. This occurrence called positive cash flow sensitivity and financial constraints are very important element for firms' performance. Financial constraints increase firm investment and its value. Financial constraints are second independent of this study. In size is significant and negative impact on cash holdings. Nguyen et al., (2016) supports our results that they explain size effect on firm cash holdings. Drobetz and Grüninger (2007) also explain that firm size and cash holdings have negative relationship.

**Recommendations**

Future studies may extend this research by examining sector specific differences in cash holding behavior within Pakistan's non-financial firms or by comparing emerging and developed markets. Incorporating macroeconomic factors such as inflation. Comma interest rates comma or exchange rate volatility could provide deeper insights into firm's liquidity management. Additionally, employing alternative methodologies such as dynamic panel model or cross-country analysis may strengthen the robustness and generalizability of findings. Exploring behavioral and governance related aspects such as managerial risk preferences or board independence would also enrich the understanding of cash management practices.

Regulators could promote greater financial transparency and reduce accounting opacity through stricter disclosures, standards and compliance monitoring's. Future studies can explore the role of regulator in this relationship.

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