Cash Holdings, Shocks, and Overconfidence

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Abstract

This thesis investigates the impacts of cash holdings on firm performance when there are negative shocks, the impacts of compositions of cash holdings on firm performance, and the impacts of overconfident executives on firm performance.

Chapter 1 demonstrates the changes in sensitivity of investments to cash holdings during operating cash flow disruptions. Defining operating cash flow disruptions as operation loss, this chapter finds investments sensitivity to cash holdings declines significantly with operation loss. The same pattern of changes is found in investment sensitivities to both optimal cash and excess cash holdings, indicating firms treat the two parts of cash holdings in a similar manner. However, the decline in post-*Loss* investment-cash holding sensitivity is detected in high-cash firms, financially constrained firms, and poorly governed firms. These firms tend to save large cash holdings initially but deplete them quickly, which leaves insufficient cash holdings for negative shocks. In contrast, low-cash firms, unconstrained firms, and well governed firms experience increase in post-*Loss* investment-cash holding sensitivity. Low needs for internal liquidity explicate the low level of and less withdrawal from cash reserves, which just increases the availability of cash holdings during negative shocks. Moreover, compared with debt-retiring firms and domestic firms that have larger decreases in post-*Loss* investment-cash holding sensitivity, firms without debt retirement and multinational firms experience fewer declines for having more cash holdings.

Chapter 2 distinguishes the impacts of cash and cash equivalent from short-term investments on firm value. Common measure of cash holdings consists of a cash and cash equivalent component and a short-term investments component. At the mean level, cash and cash equivalent increase firm value more than short-term investments, which translates into a higher value of cash and cash equivalent than the short-term investments. This is because high liquidity of cash and cash equivalent outweighs the reduced liquidity of short-term investments. This effect is more pronounced in firms without recent debt retirement. However, when liquidity is not important, the extra yield of short-term investments dominates the low returns of cash and cash equivalent. Hence the value of short-term investments becomes higher than cash and cash equivalent in firms with lower near-term liquidity needs, less financial constraints, and poorer governance.

Chapter 3 shows the impacts of CEO overconfidence on firm stock liquidity. Despite rational CEOs increase stock liquidity through more cash holdings and less investments, this chapter finds the opposite for overconfident CEOs. Firm stock liquidity increases with less fewer

holdings and more investments when the firms are managed by overconfident CEOs. Conservatism of rational CEOs reduces the uncertainty over asset-in-place, which makes firm stocks liquid. Yet, in firms with overconfident CEOs, uncertainty decreases when low cash holdings prevent wasteful spending and more investments mitigate underinvestment.

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Introduction

Maintaining sufficient liquidity is important to improvements in firm performance. Firms can plan their liquidity with either internal or external liquidity, or both. Internal and external liquidities are not perfect substitutes in the presence of financing frictions (Acharya, Almeida, & Campello, 2007). The availability of external financing is less of certainty, under which the finance and investments plans may not be optimal. Hence, firms have been focusing on cash holdings for precautionary needs in recent years (Bates, Kahle, & Stulz, 2009). However, cash holdings are not the ideal liquidity either. The impacts of cash holdings on firm performance vary because firm traits can affect the cycle of cash holdings from incentives, saving, spending, to feedback.

On the one hand, corporate investments are an important determinant of cash holdings. Precautionary cash holdings enable firms to expand without external liquidity and outperform peers. Firms frequently use cash reserves to fund investments, including capital expenditures, acquisitions, and innovation. Particularly innovation mostly accounts for the recent increase in cash holdings. When the competition grows more severe, firms are well-prepared with large cash holdings against rivalry. During downturns, cash holdings may be even more favourable among other financing in keeping firms running. Amid the 2008 financial crisis, in which external financing was rare, cash holdings become the major funding source of corporate investments. Firms with lower cash holdings cut more investments compared with their cash-rich peers. Therefore, firms save cash to prevent liquidity shortages and maintain competitiveness. However, the propensity for saving cash is not identical to the ability to save cash. Limited firm cash flows lead to the demand of firms for borrowing and the reluctance of lenders for lending. This leads to a strong precautionary motive and a great propensity for saving cash, whereas limited cash flows impede the building of a cash reserves too. In contrast, strong cash flows give firms access to low-cost external financing, which makes and weak precautionary needs. Yet, strong cash flows can make unintentional accumulation of cash, which reduces borrowing.

On the other hand, the cash holdings may not be used as originally planned to maximize firm value. The executives who have a say in the allocation of discretionary cash holdings play a vital role in shaping cash policies. Firms with self-interested managers have less cash holdings. The managers would extract private benefits from cash holdings by investing in the investments that damage firm value. Managers who are overconfident share some similarities with self-interested managers. Despite the initial large cash holdings, firms in

the charge of overconfident managers can also have less cash holdings. Because managerial overconfidence wastes cash holdings on value-decreasing investments, which are misjudged as value-increasing. Therefore, overconfidence is different from agency problem because overconfident managers act in the interest of shareholders. For cash holdings to remain easily accessible, firms prefer saving more cash holdings as liquid cash and cash equivalents over illiquid short-term investments. Under different motives, the impacts of cash holdings on firm value thus are different. Cash holdings are more valuable if they fulfil such precautionary needs. Adversely, the cash holdings related to wasteful spending are worthless. Inspired by these studies, this thesis aims to disentangle the effects of cash holdings on firm performance based on publicly traded firms in the U.S. market from 1989 to 2019. The following three chapters cover firms' cash saving habits, the composition of cash holdings, and CEO overconfidence.

Chapter 1 delves into how a company's cash attitudes and saving habits affect investments during cash inflow disruptions. There are several findings. First, this chapter finds that sensitivity of corporate investments to cash holdings responds strongly to firm cash flow disruptions. Defined as operation loss, negative operating cash flows reduce the investment sensitivity to cash holdings significantly. Prior to operation loss, corporate investments include firm capital expenditures, acquisitions, and R&D expenses, grows by 1.87% in total along with one standard deviation increase in cash holdings. Operation loss can shrink this growth to 0.9%. In the premise that there is a target level of cash holdings, firm total cash holdings are decomposed into optimal cash and excess cash. During good times, firms more frequently use optimal cash to fund investments, whereas the investments are less sensitive to excess cash. During shocks, changes in the investment sensitivity to optimal and excess cash show similar patterns, both decline a lot. Endogeneity concerns the causality between corporate investments and cash holdings, the results hold after dealing with this issue. The results explain the attitude of firms towards cash holdings, they do not strictly distinguish optimal cash and excess cash. If firms regard optimal cash as daily liquidity and excess cash as backup, the sensitivity of investments to excess cash should increase with operation loss. Furthermore, the stronger sensitivity of investments to optimal cash is because excess cash is much smaller.

Second, firms' saving habits decide the direction of changes in investment sensitivity to cash holdings amid shocks. Firms are divided into low-cash and high-cash groups based on last year-end cash levels. Compared with non-loss status, low-cash firms increase their investment sensitivity to cash holdings. On the contrary, high-cash firms decrease their investment sensitivity to cash holdings. It can be counter-intuitive, as high-cash firms should

have more cash to cover operation loss and fund investments. High level cash holdings in high-cash firms may be transitory. These firms rely heavily on cash holdings, they build large cash reserves but deplete quickly on investments. Otherwise, the large cash holdings remain overseas as foreign subsidiary incomes. Low-cash firms instead allocate limited cash flows to investments and use the remaining cash flows to build cash reserves. Other low-cash firms have alternative liquidity, they do not save and use much cash. The cash balances of low-cash firms may be small, but firms do not use them until special occasions arise. Hence, high-cash firms may have less cash holdings available than low-cash firms when shocks arrive.

Third, firm traits related to saving habits affect investment sensitivity to cash holdings amid operation loss. This chapter considers financial constraints, debt repayment, governance, and geographical diversification matters. Regarding financial constraints, operation loss decreases investment sensitivity to cash holdings in financially constrained firms but increases it among unconstrained firms. Because unconstrained firms save less cash for access to low-cost-financing, constrained firms rely heavily on internal liquidity and hold high transitory cash holdings. As for debt repayment, firms with debt maturing soon exhibit a bigger decrease in investment sensitivity to cash holdings when there is operation loss. Firms with imminent debt maturity hold high transitory cash, they use up borrowed cash for investments immediately and need existing cash holdings to retire debt. When it comes to corporate governance, operation loss lowers investment-cash holding sensitivity more in poorly governed firms. This is because poorly governed firms quickly waste cash holdings on value-decreasing investment projects, while well-governed firms can stick to the planned budgets. Last, for geographical diversification, both domestic only firms and multinational firms decrease their investment sensitivity to cash holdings in operation loss. Despite the high cash holdings overseas, multinational firms do not shift them back due to repatriation tax to fund investments or to cover shocks. In the meantime, investment-cash holding sensitivity of multinational firms drops less, as usually they are mature firms with more cash holdings domestically too.

This chapter therefore complements the research related to cash target and excess cash. For example, Lins, Servaes, and Tufano (2010) inquiry into the purposes of saving excess cash. Through surveying firms' financial executives, they show most surveyed firms differentiate excess cash from optimal cash and mainly use it in case of liquidity shortfalls. However, their targets contain only a small number of very large companies, the sample in this chapter consists of a wider range of firms. This chapter shows that the sample firms do not necessarily make distinctions over optimal cash and excess cash, they spend excess cash as

optimal cash and prioritize different uses in different conditions. Accordingly, this chapter also links to the studies explaining the relationship between excess cash and investments (Duchin, Ozbas, & Sensoy, 2010; Harford, 1999; Harford, Mansi, & Maxwell, 2008; Opler, Pinkowitz, Stulz, & Williamson, 1999).

Also, this chapter adds more details to the work investigating cash flows, financial constraints, debt, corporate governance, and diversification. For instance, Denis and Sibilkov (2009) stress some firms are in a dilemma of saving over spending cash flows. Cash holdings in a firm facing small cash flows grow slowly since they must assign a proportion as daily use. This chapter transposes the ideas above to saving habits of firms. Firms holding less cash may continue to hold the exact amount of cash, but high cash firms can create a false image of high cash holdings. Firms relying on cash holdings can exhaust cash quickly, such as financially constrained firms and overconfident executives-controlled firms, which leads to a lower level of cash than low-cash firms. Hence, low-cash firms do not have to underperform cash-rich firms. Finally, this chapter correlates to studies investgating negative shocks (Campello, Giambona, Graham, & Harvey, 2011; Campello, Graham, & Harvey, 2010; H.-C. Chen, Chou, & Lu, 2018; Duchin et al., 2010; Lemmon & Roberts, 2010). In contrast to exogenous shocks, this chapter utilizes the negative changes in a broad range of firm cash inflows. Likewise, the idiosyncratic shocks indeed curtail corporate investments. And synergetic effects of this operation loss and saving habits may force some firms to use cash holdings, which exert positive influences on investment sensitivity to cash holdings.

Chapter 2 evaluates the cash/cash equivalent and short-term investments of cash holdings separately. Most studies consider cash holdings as a simple unit. However, cash holdings are more than a single element asset. The conventional measure of firm cash holdings contains two components, i.e. cash and cash equivalent component, and short-term investments component (Cardella, Fairhurst, & Klasa, 2021). Both parts of cash holdings can be subdivided into different types of financial assets. For example, cash and cash equivalent comprise pure cash, certificates of deposits, and other highly liquid assets. Short-term investments include relatively fewer liquid assets such as corporate and municipal bonds[1]. This chapter finds the market value of cash and cash equivalent component (cash hereinafter) is different from the short-term investment component (short-term investments hereinafter) and the value fluctuates across different conditions.

First, the value of cash is higher than short-term investments at the mean level. One dollar

[1] See the Table 2-12 in Appendix B for the full description of cash and cash equivalent and short-term investments from Compustat. See Cardella et al. (2021) for a detailed sample of cash and cash equivalent and short-term investments from firm holdings.

of total cash holdings is worth 1.4, where cash is valued at 1.56 per dollar, and 1.03 per dollar for short-term investments. Put differently, one dollar of cash increases firm value by 1.56, one dollar of short-term investments increases firm value by 1.03. The difference in value stems from the difference in liquidity. Liquidity of financial assets is positively related to short notices of liquidation (Myers & Rajan, 1998). Cash is on the more liquid side on the liquidity spectrum, and short-term investments are on the less liquid side. Short-term investments must be liquidated into cash before they can be deployed by firms. The liquidation may cause a loss in value due to interest risk. Firms thus would rather hold short-term investments until maturity. In the premise that precautionary motive predominates for the purposes of cash holdings, the illiquidity quality of short-term investments cannot satisfy the precautionary needs. Shareholders are not attracted to short-term investments because these assets are less accessible for firm value improvements.

Second, near term debt retirements further lower the value of short-term investments. The value of short-term investments in firms that do not have long-term debt repayment due is 1.9 per dollar. For firms are obliged to pay down debt, short-term investments gain a value of 0.021 per dollar, and it is not statistically significant. Moreover, the long-term debt retirements affect the value of cash too. Firms without debt repayments have cash valued at 2.4 per dollar, the cash of firms required to pay down debt is worth 0.95 per dollar. The decreases in value are because retiring debt increases debtholder wealth without benefiting shareholders. Still cash is more valuable than short-term investments regardless of debt retirements because illiquid short-term investments must be liquidated before using. Liquid cash is better than at value creation among firms without debt, and better at lowering default risks among firms with debt.

Third, the value of short-term investments is higher than cash under certain circumstances. The empirical evidence reveals that short-term investments are more valuable than cash when firms have lower near-term liquidity needs, less financial constraints, and poorer governance. Although cash is discretionary, the cost of carrying is large. Conversely, the reduced liquidity of short-term investments is compensated by higher yields. Low near-term liquidity needs of firms indicate the liquidity feature of cash that is not required. Financially unconstrained firms do not require large cash holdings either, given the greater availability of external financing, which lowers opportunity costs. Saving short-term investments for these firms allows earning higher yields whilst secure distant fundings. Inferior corporate governance suggests high cash is likely to be converted into private benefits of managers, as agency costs decrease. The liquidation makes short-term investments relatively less available to self-interested agents for value-decreasing investments. Additional tests

demonstrate that the value of investments funded by short-term investments are higher than cash-backed investments. Consequently, shareholders of firms with these traits prefer short-term investments for lower cost of carry.

This chapter contributes to the literature on how firms manage the compositions of cash holdings (Azar, Kagy, & Schmalz, 2016; Cardella et al., 2021; Duchin, Gilbert, Harford, & Hrdlicka, 2017). This chapter is closely related to Cardella et al. (2021), they find cash holdings with higher proportion of short-term investments are less valuable. This chapter extends their work by confirming that on average, the value of short-term investments is lower, which can hold the overall value of cash holdings back. Meanwhile, some circumstances can increase the value of short-term investments to a higher level than cash.

This chapter contributes to works associated with cross-sectional value of cash holdings. Such as in debt, liquidity needs, financial constraints, and corporate governance. This chapter shows the balance of liquidity and yields is likely to lead the fluctuations in value through the comparison between cash and short-term investments. The value of cash holdings is subject to whether the liquidity quality of cash holdings is favoured or not in the traditional view. It is proved from the flip side by the value of short-term investments. Particularly, this chapter provides a new perspective on corporate governance. Current literature build the relationship between corporate governance and value of cash holdings by considering factors like regulations or monitoring (Aktas, Louca, & Petmezas, 2019; A. Dittmar & Mahrt-Smith, 2007; A. Dittmar, Mahrt-Smith, & Servaes, 2003; Haw, Ho, Hu, & Zhang, 2011; Tong, 2011). This chapter looks deeply into cash holdings itself and discovers that short-term investments can reduce agency costs by challenging the accessibility of cash holdings.

Chapter 3 focuses on how CEO overconfidence affects stock liquidity of firms through firm policies. Overconfidence describes a trait that individuals overestimate their professional ability. An overconfident executive believes they are superior in leading the firm business development[2]. This psychological bias leads executives to behave differently. Examining firm stock liquidity helps understand whether the market values the deviation.

This chapter has two main findings. First, firm stock liquidity increases significantly under the management of overconfident CEOs. The firm stock trading discontinuity reduces by 1.5 days and stock price impact ratio drop by 0.02. Second, CEO overconfidence increases stock liquidity by investments, while decrease stock liquidity through cash management. The

[2] Overconfidence may be explained differently among existing studies. This chapter follows the definition that overconfidence is about overestimation of one's ability to improve future returns (Malmendier & Tate, 2005) and underestimation of risks (Ben-David, Graham, & Harvey, 2013).

conclusions hold after controlling endogeneity of the overconfidence measure. A rational executive can increase stock liquidity by holding more cash, seeking more external financing, and paying out more by repurchases. These activities deliver positive signals that the company is profitable. Instead, making more investments decreases stock liquidity for increases in uncertainty. Behaviour of overconfident executives resembles those behaviour of rational executives. Overconfident executives prefer internal liquidity, but also borrow aggressively when external financing is used. They overvalue repurchase and devalue dividends. Likewise, riskiness of overconfident executives encourages investments that may decrease stock liquidity in rational firms. However, the logics behind these similar activities are different. The same policy executed by overconfident CEOs convey different messages. Stock liquidity increases when overconfident CEOs invest because underinvestment of rational CEOs is mitigated. In contrast, using more cash holdings and repurchases should decrease stock liquidity. Because overconfident CEOs wrongly believe their firms are undervalued, they refuse low-cost financing, and excessive cash holdings stimulate wasteful spending, the repurchases are also made based on false beliefs. Overconfident CEOs thus increase stock liquidity by taking opposite policies of rational CEOs.

This chapter also considers different management roles, CEO age, and corporate governance; these factors can affect the overconfidence-stock liquidity relationship. Specifically, this chapter finds although CFOs (chief financial officers) can be overconfident, they do not increase stock liquidity as CEOs do. It is either because CFOs do not have the final say over firm policies, or they are incompetent. Next, age creates different career horizons. The career horizons of younger CEOs are longer, which pushes young CEOs to make discreet decisions. Adversely, shorter career horizons of older CEOs can make them reckless. Consequently, age can affect CEO behaviour and the test results. Furthermore, corporate governance can improve stock liquidity too. The results may be biased if overconfident CEOs increase stock liquidity because they are disciplined. Additional tests indicate the main conclusions hold after controlling CEO age and corporate governance.

This chapter contributes to the literature explaining CEO overconfidence and firm performance. Previous works indicate overconfident CEOs produce both positive and negative outcomes. This chapter extends these works by proving firm management by overconfident CEOs is attractive to the market, the stocks of firms become more liquid. Especially, the firm policies adopted by overconfident CEOs receive mixed market reactions, but the positive effects of investment policies eventually lead to a stock liquidity increase. This chapter therefore complements the studies elaborating overconfidence-related distortions in firm policies too (Campbell, 2014; Campbell, Gallmeyer, Johnson, Rutherford,

& Stanley, 2011; Ferris, Jayaraman, & Sabherwal, 2013; Goel & Thakor, 2008; Heaton, 2002; Malmendier & Tate, 2005, 2008).

This chapter also develops research investigating how firm stock liquidity is affected by firm policies. Existing works discuss the problem under the assumption that related participants are rational. These works show stock liquidity co-moves with fluctuations in firm uncertainty brought by rational policies (Andres, Cumming, Karabiber, & Schweizer, 2014; De Cesari, Espenlaub, & Khurshed, 2011; Gopalan, Kadan, & Pevzner, 2012; W. Huang & Mazouz, 2018; Kothare, 1997). This chapter complements these studies by making the debate in a framework with overconfident participants. Stock liquidity is affected by uncertainty as well. However, the moving directions of stock liquidity under overconfident policies is opposed to rational policies.

Chapter 1

1 Investment-Cash Holding Sensitivity and Operation Loss

1.1 Abstract

Chapter 1 describes the changes in sensitivity of investments to cash holdings during operation loss. Operation loss reduces investments sensitivity to cash holdings significantly. The same pattern of changes applies to the investment sensitivity to both optimal and excess cash holdings, which suggests there is no difference between optimal and excess cash holdings to a mean firm. However, mostly high-cash firms, financially constrained firms, and poorly governed firms exhibit such declines in post-*Loss* investment-cash holding sensitivity. On the contrary, their low-cash, unconstrained, and well governed peers experience increase in post-*Loss* investment-cash holding sensitivity. The former firms save more cash holdings but spend more, the latter firms save less cash holdings but rarely use them; different saving patterns lead to difference in availability of cash holdings when shocks come. Moreover, when firms with recent debt retirement and firms operating domestically show a larger decrease in post-*Loss* investment-cash holding sensitivity, firms without debt retirement and multinational firms experience smaller declines.

1.2 Introduction

Cash and investment policies of firms are not planned independently. Investment is an important determinant of cash holdings (Opler et al., 1999). For example, the recent increase in the number of innovative firms pushes up the overall level of cash holdings in U.S. companies (Bates et al., 2009; Begenau & Palazzo, 2020). These innovative firms are typically start-ups with scarce external fundings. Their investments must be financed internally, which induces a strong propensity for saving cash. Cash saving incentives of big and mature firms are much weaker because of greater access to external financing. However, predictable investment opportunities can increase their interest in saving cash, too (Cunha & Pollet, 2019). Particularly during recessions, cash holdings can provide valuable liquidity to

corporate investments. The 2008 financial crisis causes a decrease in external supply of credit. Firms must cut investments unless they have internal cash holdings to replenish the external liquidity shortage (Duchin et al., 2010). Firms therefore hold cash for precautionary motive in case of liquidity shortage of investments.

A strand of existing literature addresses the precautionary motive through corporate investments reaction to cash holdings among exogenous shocks. This chapter asks how the sensitivity of investments to cash holdings changes in a setting of negative firm operating cash inflows. Particularly, how the firm's attitude towards cash holdings and cash saving habits can affect the changes in sensitivity of investments to cash holdings. Answering the question clarifies how effectively cash holdings guard corporate investments against negative shocks.

According to Opler et al. (1999), there appears to be an optimal cash level, which divides cash holdings into an optimal part and an excess part. The cash holdings below or at the target level of cash holdings are the optimal part that mainly fund investments. The excess part is the cash holdings above the target level and mainly saved for covering loss[3]. However, the attitude of firms towards the optimal cash policy may be ambiguous. If firms hold a one-for-one cash holding policy, the use of cash in one activity should not be affected by another. Precisely, investment sensitivity to cash holdings will not be affected by negative operating cash flows (operation loss hereinafter). Conversely, firms may not differentiate the use of optimal and excess cash holdings. Hugonnier, Malamud, and Morellec (2014) suggest firms hold cash to satisfy both shocks and investments. In practice, firm CFOs indicate the purposes of cash holdings are not specified (Lins et al., 2010). Firms allocate cash holdings based on priority in different situations. When operation loss becomes the top priority and consumes the cash holdings, corporate investments have fewer disposable cash holdings subsequently. Unless firms hold sufficiently high cash to cover all needs, investment sensitivity to cash holdings should decline. Firms with relatively more cash holdings should

[3] It is difficult to distinguish cash holdings for one use from another, such as the cash holdings saved for current investments/operations or future investments/operations (the precautionary motive). Because the uses of cash holdings may interwind. For instance, Denis and McKeon (2021) show firms repetitively issuing equity against persist negative cash flows, the proceeds are saved as cash holdings but depleted instantly, the motive of such transitory cash holdings are hard to be recognised explicitly. Hence, this chapter follows the trade-off theory, assuming there exists an optimal cash level, which distinguishes the optimal cash holdings from excess cash holdings. In this way, this chapter identifies the most likely use of optimal cash holdings and excess cash holdings respectively according to Opler et al. (1999), who find the changes in optimal cash holdings are mainly associated with corporate investments, and changes in excess cash holdings are mostly related to operating cash flows.

experience mild declines (Duchin et al., 2010). Firms may also decrease investments to preserve liquidity in response to unknown future shocks even they do have enough cash holdings (Campello et al., 2011). Therefore, it is likely operation loss will decrease investment sensitivity to cash holdings.

Moreover, the saving habits of firms should affect post-*Loss* performance too. Some firms have low cash holdings. It is either because they cannot build large cash reserves for limited cash sources (Chang, Dasgupta, Wong, & Yao, 2014; Denis & Sibilkov, 2009), or they can finance externally and hold less cash to lower the cost of carry (Almeida, Campello, & Weisbach, 2004). While some firms have high cash holdings. Because firms without external financing must rely on internal liquidity by holding more cash (Almeida et al., 2004; Moritzen & Schandlbauer, 2019). And firms like multinational firms can unintentionally save more cash. Their cash holdings are accumulated by foreign income. Multinational firms do not shift the cash back due to high costs caused by as repatriation tax (M. W. Faulkender, Hankins, & Petersen, 2019; Harford, Wang, & Zhang, 2017). However, low-cash firms spend less cash holdings on daily operations, high-cash firms consume the cash holdings quickly. High-cash firms can end up having less cash left than low-cash firms at the point that operation loss occurs. Accordingly, post-*Loss* investment-cash holding sensitivity increases among low-cash firms but decreases in high-cash firms.

Based on non-financial and non-utility firms from Compustat for the period from 1989 to 2019, this chapter yields the following findings.

First, investment sensitivity to cash holdings weakens as operation losses arise. Empirically, corporate investments are positively and highly significantly related to cash holdings. One standard deviation increase in cash holdings boosts investments by 1.87% in an average firm without operation loss. Operation loss is negatively related to corporate investments. It directly decreases corporate investments by 0.21%. With operation loss, one standard increase in cash holdings increases corporate investments up to 0.9% at mean level. Duchin et al. (2010) find that the one standard deviation increase in cash holdings mitigates the impact of disruption in external credit supplies for 0.104%. Although this chapter finds cash holdings constantly fund investments during operation loss, the funding availability decreases significantly. The post-*Loss* investment-cash holding sensitivity decreases by over 50% compared with pre-*Loss* sensitivity. Controlling past operation losses leads to less negative impacts on investment sensitivity to cash holdings from current operation losses. Firms may respond to continuous shocks steadily because of learning effects.

Next, the total cash holdings are decomposed into an optimal part and an excess part by estimating a target level of cash holdings. Corporate investments are more sensitive to

optimal cash holdings when there is no operation loss. However, investment sensitivity to optimal and excess cash holdings follows the same pattern of change. Operation loss decreases investment sensitivity to both optimal and excess cash holdings. There is no increased post-*Loss* investment sensitivity to excess cash holdings. In other words, firms do not draw down more excess cash to fund investments in operation loss. Hence, it is likely firms see no difference between optimal and excess cash holdings; they prioritize different uses of cash holdings in different scenarios.

Second, firms' saving habits can determine the directions of changes in investment-cash holding sensitivity. How firms save and spend cash holdings should affect the availability of cash holdings. The firms are sorted into low and high-cash groups based on the yearly medians. When there is no operation loss, high-cash firms actively finance their investments with cash holdings. Instead, low-cash firms cut investments to build cash reserves. When there is operation loss, low-cash firms display a significant positive relationship between investments and cash holdings. High-cash firms retain a positive but smaller sensitivity of investments to cash holdings. High-cash firms can save and spend cash holdings aggressively at the same time, which leads to insufficient cash holdings during operation losses. Low-cash firms save less, but they can leave all cash holdings against negative shocks. The two saving patterns thus account for the opposite directions of changes in investment sensitivity to cash holdings.

Other scenarios in which firms may have different saving habits are also considered, including financial constraints, debt retirement, corporate governance, and geographical diversification.

Third, operation loss decreases (increases) investment-cash holding sensitivity among financially constrained (unconstrained) firms. Firms are divided into financially constrained and unconstrained groups by the SA index (Hadlock & Pierce, 2010), WW index (Whited & Wu, 2006), and whether they have access to credit lines (Sufi, 2007). Financially constrained firms typically pursue a higher cash ratio since they heavily rely on cash holdings. Financially unconstrained firms are not concerned about cash holdings because they have easily accessible external financing. The empirical evidence shows constrained firms without operation loss spend more cash holdings on investments, but operation loss decreases sensitivity of investments to cash holdings drastically. Investments of unconstrained firms are less sensitive to cash holdings; operation loss instead increases the sensitivity of investments to cash holdings considerably. Additionally, there may be joint effects of the size of cash holdings and financial constraints on the investment-cash holding sensitivity. A low-cash unconstrained firms can be denied accessing external financing.

Insufficient internal and external liquidity produce the smallest investment sensitivity to cash holdings during operation loss. However, there is no consistent and supportive evidence. Only firms with low cash and having credit lines exhibit a negative and statistically insignificant sensitivity of investments to cash holdings.

Fourth, firms with less debt, better governance, and greater geographical diversification experience suffer less from operation loss. Firm leverage is negatively related to cash holdings (Opler et al., 1999). As firms substitute these two tools, cash holdings are used to retire debt (Bates et al., 2009; Cardella et al., 2021). When there is operation loss, firms first deal with debt that matures soon, which leads to a greater decrease in investments. Non-debt-paying firms experience fewer decreases in investments. Discretionary cash holdings can be wasted on value-decreasing projects (Jensen & Meckling, 1976). A good corporate governance should eliminate such disadvantage of cash holdings (Frésard & Salva, 2010; Harford et al., 2008; Pinkowitz, Stulz, & Williamson, 2006). Poorly governed firms then show lower levels of cash holdings than well governed firms (Harford et al., 2008). The results show operation loss causes a bigger drop in investment-cash holding sensitivity of poorly governed firms. Geographical diversification can contribute to high cash holdings overseas due to repatriation tax (M. W. Faulkender et al., 2019; Gu, 2017) It can also result in low cash holdings due to a better internal capital market or accessible foreign liquidity (Fernandes & Gonenc, 2016), operation loss exerts smaller negative impacts on investment sensitivity to cash holdings of multinational firms, but it heavily affects domestic-operated-only firms.

Fifth, instrumental variable is used in the 2SLS framework to confirm the causality between investments and cash holdings. Following Fresard (2010), the model instruments cash holdings with firm asset tangibility. Tangible assets increase cash holdings by improving the ability of firms to borrow. More cash holdings provide more liquidity to make investments. However, tangible assets do not increase corporate investments directly. The results affirm the conclusions hold after instrumenting cash holdings.

Overall, this chapter finds cash holdings help resist operation loss, but the effects are subject to firm saving habits.

This chapter extends the existing literature in several ways. First, it complements the research related to optimal cash (Duchin et al., 2010; Harford et al., 2008; Lewellen & Lewellen, 2016; Lins et al., 2010; Opler et al., 1999). Current literature is ambiguous on whether firms consider optimal cash and excess cash differently. An early study by Opler et al. (1999) shows different activities respond to optimal cash and excess cash in different ways. Hugonnier et al. (2014) theoretically suggest firms hold cash for both investments and

negative shocks. Financial professionals also explain cash holdings are for general purposes. This chapter implies excess cash holdings are not strictly distinguished from optimal cash holdings (Lins et al., 2010). Second, this chapter is related to the works investigating cash flows, financial constraints, debt, corporate governance, and diversification (Almeida & Campello, 2010; Almeida et al., 2004; Duchin et al., 2010; Opler et al., 1999). This chapter translates these conditions into firms' saving habits. For instance, low cash flow firms either save out of cash flows, or spend cash flows on investments (Denis & Sibilkov, 2009). Building a small cash reserve does not represent a lower investment sensitivity to cash holdings during operation loss. Finally, this chapter is related to literature regarding negative shocks (Campello et al., 2011; Campello et al., 2010; H.-C. Chen et al., 2018; Duchin et al., 2010; Lemmon & Roberts, 2010). This chapter explores a broad idea of firm operating cash flows shocks instead of exogenous shocks. Operation loss curtails corporate investments as exogenous shocks do. However, investment sensitivity to cash holdings can either increase or decrease during operation loss depending on saving habits.

This chapter is arranged as follows. Section 1.3 provides an overall description of existing studies relevant to this chapter and constructions of the hypotheses; Section 1.4 develops variables and the baseline model; Section 1.5 and 1.6 demonstrate the empirical results and detailed explanations; Section 1.7 gives conclusions.

1.3 Literature Review and Hypotheses Development

1.3.1 Determinants of Cash Holdings

Firms build cash reserves for a series of reasons. Precautionary motive is one of the most common explanations; firms hold cash to capture growth opportunities in case other liquidities are not available.

1.3.1.1 Corporate Investments

Therefore, according to the precautionary motive, firms hold cash eventually to fund corporate expansion, which in turn decides the firm cash policies. For example, Harford (1999) uncovers the relationship between cash holdings and acquisitions. Firms with cash holdings exceeding the optimal level are significantly more likely to acquire other firms. These firms are particularly interested in targets that are not related to their core business. They also like to pursue targets that are not attractive to other firms. Nevertheless, these

acquisition strategies do not increase firm value. Firm abnormal returns decrease as the bids are announced. Following successful deals, the return on assets of merged firms declines sharply. Consequently, shareholders expect high cash to incur agency costs unless to be paid out.

Opler et al. (1999) discover the accumulation and spending patterns of corporate cash holdings. They first show both the static trade-off model and financing hierarchy model to explain the motive behind cash savings. The former supports the optimal cash level theory, whereas the latter is against the optimal cash view. The static trade-off model shows the firm size, net working capital and leverage are negatively related to cash savings, while firm cash flow, investments, and industry cash flow volatility increase cash balance. Subsequently, the static model predicts the optimal levels a firm should have, the comparison with actual cash indicates there exists excess cash, namely the part of cash holdings exceeds the optimal level. However, changes in corporate investments (capital expenditures and acquisitions) and payouts are only weakly sensitive to excess cash holdings, regardless of the growth environment, and the extent to which positive excess cash increases investments is lower than what negative excess cash decreases investments. Instead, firms would rather keep the excess cash holdings, unless negative operating cash flows require withdrawal from excess cash.

Haushalter, Klasa, and Maxwell (2007) appraise the effects of predation risk on corporate financing and investments, where predation risk refers to the situation that business rivals take advantage of the underinvestment of other firms and seize more growth opportunities and market shares. As predation risk is positively related to the interdependence of growth opportunities among firms, it is measured by industry concentration, operation similarity, and correlation of investment opportunities. Greater predation risk encourages firms to hold more cash and use more derivatives. This effect is stronger for firms in high-growth industries, which magnifies the predation risk. However, firms either save cash or use derivatives, instead of both at the same time. Firms also respond to predation risk by making more investments during industry downturns if they have sufficient cash.

Using textual analysis based on 10-K filings, Hoberg, Phillips, and Prabhala (2014) construct an index, fluidity, which measures the relative change in products of rivals to firms, a higher value indicates greater market threats. Based on the measure, they find greater market threats decrease payouts, especially dividends, because repurchase is only a one-time cost, whereas dividends pay regularly. Firms also increase cash holdings significantly to resist market threats, financially constrained firms are more likely to increase cash due to a lack of external financing.

Cunha and Pollet (2019) use the shifts in U.S. demographics to forecast growth in related consumer goods, which creates known investment opportunities for firms to save precautionary cash. Empirical estimations indicate future investment opportunities induce cash holdings to increase by 16%. As financial constraints create a wedge in the costs of external financing, constrained firms increase cash holdings significantly in response to the growth opportunities, and they also start to save 6 years ahead of the investments, which incurs high opportunity costs; unconstrained firms react much less actively, they start to save 2 years before the investments. Constrained firms build cash reserves by saving from cash flows and dividend reductions, while unconstrained firms save from equity issuance. Since the future growth opportunity is only observed by firms, information asymmetry allows unconstrained firms to repurchase undervalued shares, which decreases cash levels, and re-issue equity and debt as the information asymmetry disappears. Constrained firms instead are unable to repurchase, but they do issue debt as approaching the point of investing. Finally, the changes in cash holdings during the period of making investments confirm that the spending matches exactly the amount firms save.

However, the role of innovation becomes more prominent than other types of investments in affecting cash holdings across time. Bates et al. (2009) explicate the reasons for increasing cash holdings among U.S. firms. They first record that firm cash holdings increase by 0.46% every year and total cash holdings at the end of the sample period increase twice more than the beginning of the sample period. And this increase contributes to a significant decrease in the firm net debt. Empirically, the increase in cash holdings is because of declines in payouts, higher cash flow volatility and greater return risks (e.g. newly listed firms) that explains precautionary motive. However, the main cause is because of changes in firm characteristics. Specifically, firms hold less working capital, inventories, accounts receivables, and shifts of investments from capital expenditures to innovations.

He and Wintoki (2016) argue that the increase in cash holdings is because the sensitivities of cash holding to its determinants change, not changes in determinants. Specifically, out of one dollar of corporate spending on innovation, 0.04 dollars come from cash in the 1980s, but it increases to 0.6 per dollar in the 2010s. Using OLS and difference-in-difference tests that are based on the event of import tariff reduction respectively, they show exogenous market competition has increased rapidly, which drives the increase in cash of R&D firms but not non-R&D firms.

Graham and Leary (2018) probe the drivers of changes in average and aggregate cash holdings of U.S. public firms across the past century. Graphs first demonstrate that the patterns of average and aggregate cash are similar before the 1980s, whereas after the 1980s,

the growth of average cash is much more rapid, aggregate cash remains relatively flat, and new public firms account for the difference in these two patterns. Cross-sectional regressions find firms hold cash for the same reasons in the past. However, the increase in new publicly traded firms in NASDAQ since the 1980s drives the increase in average cash, because these firms feature high growth, high industry volatility and unstable profitability, hence precautionary motive is strong for them. Aggregate cash is affected by productivity at the macro-economy level and is affected by profitability and investments at the firm level. Firms simultaneously save and spend, which leads to imperfect adjustments to target cash.

Begenau and Palazzo (2020) indicate the increase in cash holdings in U.S. public firms is because of changes in the composition of newly listed firms. These firms are largely R&D-intensive firms, which are smaller and have greater fluctuation in productivity, they hold high balances to counter the effects of negative profitability and remain high cash until their productivity becomes stable.

1.3.1.2 External Financing

Another premise of the precautionary motive is liquidity shortfalls. Without sufficient funding, firm policies may be distorted.

Campello et al. (2010) determine the effects of constraints on firm policies during the financial crisis. They measure financial constraints by the subjective view of firm CFOs across 39 countries. A firm is financially constrained if its CFO believes it is, otherwise, it is unconstrained. Empirically, constrained firms first exhibit conservatism in spending plans. Financial crisis reduces significantly firm budgets for employment, technology, capital expenditures, marketing, and dividends. In the meantime, constrained firms deplete more cash holdings. They are found to have greater credit lines to total assets ratios. They draw down more credit lines today for future needs, as firms fear access to credit lines will be restricted later. Most constrained firms forgo existing and future growth opportunities unless they can fund externally. Although, at the aggregate level, firms suggest they tap internal liquidity, like cash holdings and cash flows. In contrast, unconstrained firms experience far fewer negative impacts in the above dimensions.

Focusing on U.S. below-investment-grade firms, Lemmon and Roberts (2010) measure the effects of contraction in the supply of credit. The three events, including closure of Drexel, the passage of FIRREA, and changes in NAIC credit rating rules, lead to a sharp decline in external funds for below-investment-grade firms. The decline mainly lowers net debt issuance, it decreases total net debt and equity issuance by 5% of firm assets. Given the

difference-in-difference test results, firms do not have cash, trade credit, or other liquidity against credit supply reduction. Corporate investments thus decrease by 5% of firm assets. Larger reductions in credit supply in the northeast U.S. make firms headquartered in the area reduce more investments. Furthermore, risky firms experience greater reductions in external financing and investments, and this negative experience lasts longer for them.

The model of Almeida, Campello, and Weisbach (2011) theoretically explains how future financing constraints affect investment decision-making. Rather than use the NPV rule, firms decide on investments based on the payback period and risks. Because without external financing, firms need cash flows from investments with shorter return periods and lower risks to fund future investments, especially in a downturn. Firms also tend to lower the risks of liquid investments to facilitate future financing. All else unchanged, an increase in external financing costs deepens the preference of firms for safe investments and investments generating cash flows fast, but this effect can be offset by the growth of internal liquidity.

To avoid liquidity shortages and corresponding changes in investment plans, firms tend to build cash reserves. Financing frictions that restrict access to external financing and cause liquidity shocks consequently are important in cash management.

Harford, Klasa, and Maxwell (2014) consider the effects of debt maturity on firm cash policies. Panel regressions first address the reduced long-term debt maturity across time, although the total amount of long-term debt remains stable. Long-term debt with shortened maturity significantly increases firm cash holdings due to greater refinancing risks, this effect is stronger for firms with more debt or during bad times. And the more such debt, the firms have stronger incentives to save out of cash flows. Conditional on having access to credit lines, financially constrained firms continue to save cash for mitigating refinancing risks, but not unconstrained firms, which suggests financial constraints drive different views in substitutions of liquidity. Subsequently, firms with long-term debt with shortened maturity can rely more on cash to make investments, especially in a tightened capital market. The cash holdings thus become valuable for these firms, and more valuable when the market is tightening.

Hugonnier et al. (2014) explain how frictions affect firm policies. In addition to financing friction, another friction considered is that investments are lumpy. The model indicates that when there is financing friction and no investments, it is optimal to set target cash, where cash serves operating loss, and firms maintain cash level through managing payouts. If firms invest and the investment cost is low, cash serves both operating loss and investments, firms again set target cash, they retain earnings and invest if cash is above target or if they have

external funds. Instead, if firms invest and the investment cost is high, firms do not follow the target cash policy unless the cash balance is above the target level. In other words, when cash is below target following an operating loss, firms only distribute cash and then re-start accumulating cash, but firms should invest entirely with external funds since the re-accumulation of cash is costly. They also show any firm can fund investments both internally and externally, but firms do not invest before securing external funds. Moreover, internally funded investments increase with tangibility, agency costs, stable cash flows and lower market depth, and firms make fewer investments even if they have enough liquidity when credit supply decreases.

Armenter and Hnatkovska (2017) understand the attractiveness of costly equity issuance even debt further features tax advantages. Their model shows that firms issue equity at high costs because they have cash flows distributed to shareholders and have limited access to debt financing. To avoid financing constraints in a future bad state, they would rather build cash reserves by paying high costs to issue equity when in a good state ahead.

Based on textual analysis using 10-K filing, Friberg and Seiler (2017) decompose uncertainty into two parts, predictable (risk) and unpredictable part (ambiguity). Ordered probit regressions indicate both risk and ambiguity increase credit risks through lower S&P ratings. Ambiguity also significantly increases the firm level of financing constraints. Firms deal with ambiguity with cash holdings but use derivatives for risk.

Rongbing Huang and Ritter (2020) match the duration of liquidity needs and types of security issuance. Defining net debt or equity issuers as firms with a ratio of net debt proceeds over book assets or a ratio of net equity proceeds over market value are equal to or larger than 5% and 3% respectively, they find these net issuers would face immediate cash shortfalls if they had not tapped the capital market. Particularly, firms are more likely to issue debt than equity with such needs. In contrast, small firms, high-growth firms, unprofitable firms, and R&D-intensive firms are more likely to issue equity. Because these firms usually have cash needs that last longer over time due to persistent inferior operating performance and these firms may have fewer tangible assets to facilitate debt issuance. Moreover, since net equity issuers are more likely to have long-term cash needs and equity issuance is costly, they save a larger fraction of proceeds than net debt issuers, especially when the issuance costs increase.

Moritzen and Schandlbauer (2019) contemplate the impact of easing financing frictions on cash holdings. Through difference-in-difference tests based on U.S. Securities Offering Reform in 2005, which simplifies the SEO process, they find the shorter time that firms take to acquire external funds, the less cash firms hold. This effect is stronger for firms with

greater pre-emption risk, which describes that first-movers win the competition. Large cash holdings originally used to hedge against pre-emption risk are no longer required because of easier access to external financing, firms with greater pre-emption risk reduce cash holdings more aggressively. The impact of less time frictions on cash holdings is further intensified by a series of factors. These factors include higher acquisition opportunities, hostile takeover likeliness, more R&D spending, shorter investments, and a non-innovation intensive environment. The time-to-finance effect is also more pronounced for unconstrained firms and firms with credit lines. Robustness test indicates the reduction in cash is not because of cheaper financing costs.

Therefore, firms tend to hold less cash if frictions were eliminated and there were alternative resources available. Bank line of credit is one of the instruments that firms may consider as a substitute for cash holdings.

Sufi (2007) focuses on the trade-off between firm use of cash and credit lines. Given hand-collected data on credit lines from 10-K filings, empirical evidence suggests the level of cash flows is positively related to the likeliness of using credit lines and negatively related to cash holdings, thus high cash flow firms are also found to have a higher proportion of credit lines over their total liquidity. However, firms only outweigh credit lines over cash if they do not face financial distress unless distressed firms have high cash flows. Because distressed firms are highly likely to experience disruption in cash flows, which incurs covenant violations and curbs the use of credit lines. This applies to both current and expected (future) cash flows. The author also constructs a measure of financial constraint based on credit line access and this measure outperforms other methods in predicting the cash flow sensitivity of cash.

Lins et al. (2010) investigate the use of credit lines and non-operational (excess) cash across firms from 29 countries through a survey targeting chief financial officers in 2005. The survey indicates when 15% of median firm assets are credit lines, median excess cash only accounts for 2% of firm assets, although median total cash makes up approximately 10% of firm assets. The survey also reveals that in practice, firms hold credit lines and excess cash for different purposes. Mixed survey and empirical evidence show credit lines mainly provide funds for investments, whereas excess cash hedges future cash flow shortfalls and is not related to specific purposes. Empirically, firms do not consider the two instruments to be substitutes, unless their profitability is high and governance is good because credit lines can be terminated in case of low cash flows and high agency costs. Smaller firms, private firms, and dividend-paying firms appear to hold more excess cash, since their financing options are expensive due to information asymmetry or financing options are limited generally, or they wish to smooth dividend payment in the future. Firms use more credit lines

when external financing is needed, or equity financing is costly. A poor credit market encourages firms to use more credit lines, but also makes it less likely to consider credit lines and excess cash as substitutes. Finally, regression results show in most empirical strategies, firm total cash is appropriate to replace excess cash.

Campello et al. (2011) acquired detailed information on firm liquidity management during the financial crisis through surveys of CFOs across countries. The univariate comparison indicates that although unconstrained firms have greater access to credit lines and are better at renewing credit lines, it is the constrained firms, such as small, private, non-rated and less profitable firms, that have a larger ratio of credit lines over firm assets and have higher drawdown ratios. Cash flows (profitability) increase the credit lines to firm assets ratios, but the positive relation weakens as firms have more cash holdings. Also, with an increase in cash flows and cash holdings, firms draw down fewer credit lines because costs of credit lines increase on average, especially for constrained firms. The evidence suggests internal and external liquidity are substitutional. However, there is no proof of increased covenant violations, only 10% of firms violate and two-thirds of these firms still can renew credit lines at a higher cost, which subsequently reduces drawdown. Finally, firms only expand (technology, capital expenditures, and employment) in response to an increase in credit lines with high cash. Alternatively, they choose between investments and saving cash unless they have access to credit lines.

Acharya, Almeida, and Campello (2013) explore how firm deployment of credit lines and cash holdings is subject to aggregate risks both theoretically and empirically. They find greater exposure to aggregate risks induces firms to use more cash and fewer credit lines because systematic risks reduce the supply of credit and increase liquidity risks for creditors, who later increase the costs of credit lines and encourage firms to turn to cash holdings. Exposure to banking industry systematic risks accelerates the use of cash. The negative relation between exposure to systematic risks and credit lines (positive relation with cash) is stronger for financially constrained firms, and firms with higher aggregate risks. The relation also is stronger during periods with greater aggregate volatility.

Acharya, Almeida, Ippolito, and Perez (2014) examine the change in credit lines and cash holdings along with firm performance. Their model first explains that revocable credit lines discourage risk-taking behaviour that leads to liquidity shocks. Because creditors would impose monitoring and reject credit line drawdowns to avoid negative NPV of the lending, firms cannot use credit lines as insurance against negative shocks. Firms with high liquidity risks thus use more cash, but fewer credit lines, which is more costly to them, either because of the incorporated monitoring expenses ex-ante, or revocation-incurred loss in current or

future investments ex-post. Likewise, firms with high hedging needs use fewer credit lines. Because these firms have low cash flows, creditors can revoke credit lines and cause disruption in liquidity for current and future investments. Yet low hedging needs firms to use more credit lines since they maintain high profitability, consequently, their credit lines trigger fewer covenants and revocations. Based on credit lines data from Capital IQ, and utilizing the GM/Ford downgrade, which stirs greater liquidity risks for bond-financed firms, as a quasi-experiment, they show increases in liquidity risks make firms shift liquidity from credit lines to cash. They also empirically confirm that increases in hedging needs decrease the use of credit lines due to high costs. Meanwhile, declines in firm profitability increase the likelihood of revocations of credit lines, but shocks to profitability are generally likely among firms that have access to credit lines. Contingent on liquidity shocks, still firms can draw down credit lines, whereas cash holdings stand a greater chance to be employed against the shocks.

Finally, Almeida, Campello, Cunha, and Weisbach (2014) provide an extensive review of liquidity management through a model in which the precautionary motive roots in the moral hazard problem, as the moral hazard problem halts external financing. Their model confirms several existing findings. First, cross-sectional cash holdings are dependent on investments and the likelihood of cash shortfalls (or access to external financing), while the time series increase of cash is because of either lower costs or higher benefits of holding cash. Second, increase in cash flows of constrained firms fund current investments, and future investments by cash retention. Third, preserving debt capacity differs from holding cash to the future in that liquidity shocks may limit access to debt, while cash guarantees the availability of liquidity unless firms use up the debt capacity and bring the proceeds to the future like cash holdings. Fourth, derivatives and credit lines are committed as cash that provides unconditional liquidity in bad times by transferring cash flows from good times. Fifth, however, derivatives and credit lines are imperfect. Fully hedging idiosyncratic risks of firms by derivatives increase agency costs, credit lines can be revoked in increased liquidity risks, and aggregate risks reduce the supply of credit, firms with high correlation with aggregate risks may be restricted to access credit lines. Sixth, they address the concerns over the measure of cash holdings. A large proportion of cash holdings measured in studies are illiquid and unsafe financial instruments in opposition to the assumption of being safe and liquid. Literature also mixes up home cash and cash held overseas and considers the definition of cash holdings differently from practice. Seventh, large cash holdings incur agency costs. They also reviewed studies on relations between liquidity management and firm investments, and the relations during financial crisis.

1.3.1.3 Cash Flows

Cash flows affect the use of credit lines. Some studies have suggested that the ability of firms to generate internal funds can also affect external financing policies.

Almeida and Campello (2010) discuss the relations between firm profitability (cash flows) and demand for external financing. In contrast to the traditional view that believes high financing costs of financing curbs external financing, empirically they find financially unconstrained firms with low financing costs use less external financing with increases in internal cash flows, because of adjustment costs of capital structure. However, financially constrained firms with high financing costs treat increased cash flows as extra liquidity that can directly fund current and future investments and can be converted into tangible assets to secure more external financing, instead of using increased cash flows to replace existing external financing (both debt and equity). External financing in financially constrained firms responds more strongly to external profitability during recessions due to greater financial constraints.

However, this ability to generate funds internally also determines cash holdings. Theoretical and empirical works of Almeida et al. (2004) model the effect of financial constraints on cash policies. They show that financially constrained firms are more inclined to build cash reserves by saving from cash flows, whereas financially unconstrained firms display no such propensity. This is because cash enables firms to invest, but the need for cash to fund investment decreases with the availability of external financing. Financially constrained firms, those with limited access to external financing, react to future funding needs by starting to save today, whilst balancing the opportunity costs of holding cash today (i.e. potential profits if investing today) and the benefits of future investments. Instead, unconstrained firms having greater access to external financing show no desire in saving. Moreover, in economic recessions, firm cash flows shrink, and the attractiveness of current investments weakens, constrained firms exhibit a higher propensity for cash flow sensitivity of cash.

Acharya et al. (2007) distinguish cash holdings from debt capacity. Although both cash and debt capacity leaves financing for future investments, future cash flows create differences in the value of these two instruments. Future high cash flows support the high future value of debt, while low cash flows decrease debt value. If growth opportunities in the future are likely to be accompanied by low cash flows (i.e. high hedging needs), constrained firms would like to save cash from internal resources or debt issuance at present and bring the cash to the future. In contrast, if cash flows in the future are high (i.e. low hedging needs),

constrained firms would rather pay down debt with current cash flows and preserve debt capacity. However, future cash flows are irrelevant to the current financial decision-making of unconstrained firms, thus cash and debt capacity make no difference. Empirical evidence further confirms that future hedging needs (low correlation between future cash flows and investments) do not affect unconstrained firms to pay down debt using current flows. And constrained firms save cash in response to high hedging needs but preserve debt capacity in low hedging needs.

Chang et al. (2014) specify the value of allocation of incremental cash flows. Specifically, on average, with one additional dollar of cash flows, U.S. firms primarily use it to build cash reserves, followed by debt reductions, and investments, but much less for equity reductions and dividend payments. Contingent on being constrained, firms are more likely to allocate more incremental cash flows to replenish cash holdings, followed by preserving debt capacity, but less likely to spend on investments compared with unconstrained firms, because constrained firms would rather prepare for future financing constraints.

Disatnik, Duchin, and Schmidt (2013) uncover the role of cash flow hedging in firm liquidity management. Firms report floating rate debt issuance as required by updated accounting standards. Floating rate debt help firms secure financing but not interest rates, therefore, this instrument is mainly issued to hedge against cash flow risks. Both univariate and multivariate regressions signal this cash flow hedging is correlated with industry traits. Using 2SLS, they first estimate the value of cash flow hedging by controlling industry effects, in subsequent tests, the estimated cash flow hedging significantly increases the proportion of credit lines over firm total liquidity. They show cash flow hedging increases credit lines and decreases cash holdings in separate tests. And finally, cash flow hedging contributes to firm value growth that is proxied by the market-to-book ratio.

Denis and McKeon (2021) reveal that increased intangibility alone is insufficient to explain the growth of cash balance, it is the persistent negative net cash flows that drive the high cash holdings. They first report that since the 1970s, the magnitude of negative net cash flows has increased to more than two-thirds of the total firm assets, and these firms spend four times longer time to reverse the negative net cash flows. Subsequent evidence suggests only firms with both high intangibility and negative net cash flows display such increases in cash holdings. Furthermore, firms expect the negative net cash flows to persist, they respond by building cash reserves using equity issuance proceeds, especially for high intangibility firms. However, the cash firms save is just enough to cover the current negative net cash flows, the cash holdings thus become transitory and are depleted quickly, firms must launch another equity issuance to save cash and cover the next shocks, which makes cash holdings

fluctuate in jagged patterns.

Nevertheless, firms cannot save as much as they wish from cash flows. Denis and Sibilkov (2009) unfold the rationales behind the relation between cash value and financial constraints, and rationales of low valuable cash holdings. As financial constraints restrict access to external financing, constrained firms hold more cash to fund investments in response to shortages of external liquidity, particularly in constrained firms with high hedging needs, these investments subsequently contribute to greater increases in firm value. Accordingly, cash is worth more among constrained firms. However, some constrained firms are unable to build large cash reserves despite the cash being valuable, because they have both limited internal and external financing, especially persistent negative free cash flows, insufficient resources are hard to support high cash balances while meeting other needs, such as investments.

In addition to financial policies, cash flow is closely related to corporate investments. Alti (2003) models the sensitivity of corporate investments to cash flows on the premise that external financing is frictionless. The model suggests that investments and cash flows are significantly related, especially for younger and smaller firms that face more growth opportunities and pay fewer dividends. This is because cash flows are informative about firm investments, firms respond to such messages by actively adjusting investments. However, they indicate Tobin's Q measures long-term opportunities rather than current investments, cash flow is better at capturing short-term growth opportunities.

Almeida and Campello (2007) gauge the effects of tangible assets on investment-cash flow sensitivities. The ability of tangible assets to repay debt reduce the risks of loss in lending for creditors, firms that have limited access to external financing, i.e. financially constrained firms, thus benefit from tangible assets for more borrowing. But firms with excessive tangibility should be unconstrained firms, as only they can afford massive tangible assets, and unconstrained firms have better access to external financing without tangible assets. Consequently, the empirical evidence indicates sensitivities of investments to cash flows increase significantly in financially constrained firms, but not in unconstrained firms.

The inclusion of control variables for growth opportunities brings divergence over the sensitivity of corporate investments to cash flows. Ağca and Mozumdar (2017) clear up the problems by using different measures of Tobin's Q, which proxies growth opportunities. Specifically, they confirm that cash flows as internal funds are significantly positively related to investments, especially for financially constrained firms that suffer market frictions and must use internal liquidity. The results hold for different methods of Tobin's Q, including the common stock-based measure, analyst forecast-based measure, and high-order

moment-based measure. And the results are also robust for the instrumental variable and GMM model, which confirms that stock-based Tobin's Q is better.

Lewellen and Lewellen (2016) study the relations between investments and cash flows while introducing new empirical methodologies. Specifically, based on the new measure of cash flows that eliminate the non-cash spending correlations, OLS regressions detect strong positive sensitivity of investments, which include working capital, fixed assets, and acquisitions, to both current and lagged cash flows; firms also use cash flows to build cash reserves and preserve debt capacity, followed by dividend-paying and share repurchasing. They also show corporate investments are more sensitive to expected cash flows, less so to unexpected (excess) cash flows, and the former is positively related to debt borrowing, the latter is positively related to debt reduction. Using financial constraint criteria developed according to forecasted cash flows, constrained firms spend a larger proportion of cash flows on investments and less on payouts, which is opposite to unconstrained firms. Further controlling measurement error in Q through IV estimation, the sensitivity of investments to cash flows decreases, especially for financially unconstrained firms.

Minton and Schrand (1999) reflect on the effects of cash flow volatility on firm investments and financing plans. Increased firm cash flow volatility decreases corporate investments permanently instead of delaying them. It is because greater cash flow volatility increases the costs of external financing, which subsequently reduces corporate investments. Firms may not reduce cash flow volatility to pursue low-cost external financing as the cost of reducing volatility can be high. And both current and lagged cash flow volatility is positively related to costs of external financing, and costs of external financing may remain high if the cash volatility is expected to persist, even if the current volatility is reduced.

1.3.1.4 Diversification

Other than the precautionary motive, U.S. firms operating across countries may passively accumulate cash overseas due to the high costs of shifting the cash back to their home country.

Pinkowitz, Stulz, and Williamson (2015) examine the causes of cash level differences between U.S. firms and foreign firms. Through the comparison between means and medians of U.S. firms and foreign firms, they find U.S. firms hold more cash at the mean level and peaked before the 2008 financial crisis, whereas the median difference shows U.S. firms hold less cash. This suggests the cash holding is skewed and the difference is driven by certain firms. Consequently, they find U.S. firms hold less cash at both mean and median

levels after R&D-intensive firms are excluded. Likewise, U.S. multinational firms that are considered to hold more cash than foreign peers become firms that hold less cash at both mean and median levels once R&D-intensive firms are removed.

Hanlon, Lester, and Verdi (2015) link foreign cash holdings associated with repatriation tax to corporate investments overseas. Higher foreign cash increases the likelihood and number of foreign acquisitions, and foreign capital expenditures, but increases R&D both overseas and domestically. However, foreign cash induces negative market reactions around the time of foreign acquisitions, which indicates these acquisitions decrease firm value. Moreover, firms immediately reduce foreign acquisitions after the repatriation tax is reduced, which facilitates the shift of foreign income at low costs.

Given the theoretical model and simulated numerical data, Gu (2017) find that repatriation tax is the major reason for cash difference between multinational firms and domestic firms, followed by systematic firm characteristics, of which intangibility explains around half. Further estimation indicates corporate inversions among U.S. firms cause tax loss of the Treasury to reach over two million. However, the firm value increases with the inversions.

Harford et al. (2017) find foreign cash is assigned a lower value by the market, but the discount disappears once the repatriation costs are gone. The reduction in the value of foreign cash is greater for financially constrained firms and poorly governed firms because of domestic underinvestment and foreign overinvestment. Despite the high cash overseas, multinational firms do not transfer them to their home country due to repatriation tax, firms that only have access to costly external financing domestically consequently underinvest due to insufficient liquidity. These firms only make domestic investments with domestic cash flows, especially when foreign cash is high, and they do not expect foreign cash to cover domestic shocks unless the repatriation cost is low. Conversely, firms actively fund foreign capital expenditures and acquisitions with foreign cash, followed by a drop in abnormal returns contingent on these firms having large foreign cash.

M. W. Faulkender et al. (2019) clarify the relationship between cash holdings and taxes. Through the decomposition of domestic and foreign cash holdings of multinational firms, they show the surge in total cash is driven by increasing cash in subsidiaries overseas. Firms hold domestic cash out of precautionary motive, whereas foreign cash is largely due to repatriation tax. Because foreign incomes of U.S. firms are taxed when they shift back to the U.S., they would rather leave the income overseas until the tax rates decline. Moreover, intercompany transactions and intangibility push up the increase in foreign cash, it is because R&D firms can shift income from regions with high taxes to low-tax areas by taking advantage of discretionary pricing of intangible assets and intercompany sales.

Yet repatriation tax caused by geographic diversification of operation is not the only route that contributes to changes in cash holdings.

Fernandes and Gonenc (2016) analyse sizes of cash holdings through geographic and industrial diversification. Cash holding is negatively related to the degree of being (internationally) geographically and industrially diversified, respectively. This is because geographic diversification provides wider choices of external financing across countries and it exposes firms to lower correlated cash flow risks, while industrial diversification allows firms to reallocate internal resources efficiently through their internal capital market, large cash holdings thus are unnecessary. However, firms hold more cash if they are both geographically and industrially diversified, and the effect of geographic diversification entirely outweighs the other.

Bakke and Gu (2017) advise theoretically that industrial diversification reduces cash holdings for two reasons. First, the process of being diversified costs a fortune, firms invest more and pay a one-time diversification cost equivalent to 3.8% of firm assets to become diversified. Also, during this process, an efficient internal market allows diversified firms to reallocate and spend cash, which decreases cash holdings. Second, because diversified firms are large and profitable, they choose to remain low cash balances. At this stage, diversified firms may not actively reallocate cash to mitigate investment disparity and refocus, and they may have to pay 46% more on external financing costs and 55% more on capital adjustment costs. Additionally, low cross-divisional correlations encourage more firms to become diversified, and cash difference across firms decreases.

1.3.1.5 Other

Harford et al. (2008) untangle the effects of corporate governance on U.S. firm cash holdings. Using insider ownership and G-Index as major proxies for quality of governance, they find poorly governed firms hold less cash since cash holdings are at managers' discretion and managers have incentives to extract private benefits. Further evidence indicates weak governance together with excess cash leads firms to invest more in capital expenditures and acquisitions but less innovation spending. In general, well-governed firms distribute excess cash with dividends, whereas poorly governed firms make repurchases to reduce future payouts. Empirical evidence also suggests that weak governance and excess cash exacerbate profitability and firm value.

A. K. Dittmar and Duchin (2010) first compare the patterns of different levels of unexpected cash and show they converge across time, but firms do not completely adjust to a certain

point anytime, and there is a large transitory part of cash. On average, the speed of adjustment to target cash is 0.2 to 0.4 (where 1 is a perfect adjustment), economically firms take 1.4 to 3.1 years to reduce half of the distance from the current cash level to target cash. However, firms with large net debt and equity issuance and large investments adjust cash holdings faster, which suggests the existence of adjustments and optimal levels of cash. Firms adjust imperfectly because of adjustment costs, consequently firms with negative excess cash adjust slowly in contrast to positive excess cash, whereas firms with substantial negative cash adjust faster due to low marginal adjustment costs. Credit lines that provide low-cost financing also enable faster adjustment. Similarly, very low or high free cash flows make firms adjust cash holdings quickly, but average low free cash flows incur large adjustment costs. In addition, improved governance adjusts cash more quickly. They also find adjustment costs drive the positive relationship between cash holdings and cash flow volatility since firms adjust slowly with costs.

1.3.2 Feedback of Cash Holdings

Since the precautionary motive explains a large fraction of cash holdings, cash holdings subsequently become crucial in improving firm performance.

Fresard (2010) assesses the effect of cash holdings on firm performance. Using z-scored and instrumented cash holding variables that reflect financial strength relative to rivals, regressions indicate higher cash holdings significantly help firms to seize product market shares. This effect is stronger when firms have no debt capacity, namely when they are financially constrained and have high hedging needs. The effect of cash holdings on market shares also grows when rivals are more constrained, and when firms are in an industry where competitiveness is large, firms are similar and interdependent. Through difference-in-difference tests based on import tariff reduction that increases competitiveness, they confirm cash holdings are positively related to market shares. Market returns and returns on assets also react to greater cash holdings with positive responses.

Brown and Petersen (2011) quantify the effects of cash holdings and financial constraints on corporate innovation. Based on U.S. firms from the 1970s to 2000s, they show young firms that face financing constraints rely heavily on cash holdings to smooth innovation, this sensitivity of innovation to cash holdings increases across time as R&D expenses grow significantly during the sample period. They also find the relationship between cash and innovation of young firms is stronger during periods where equity financing is not available, the cash holdings help lower the innovation volatility by 75%. However, these conclusions

do not hold for mature firms that have access to alternative resources. Furthermore, the R&D sensitivity to cash holding is also strong for constrained firms using other criteria, such as non-dividend paying firms, small firms, and non-rated firms. The evidence explains that innovation is the key factor driving increases in cash holdings, and large cash holdings suppress fluctuation in aggregate innovation, so cash is valuable as it insulates R&D from shocks.

Lyandres and Palazzo (2016) investigate the strategic motive of cash holdings in innovative firms. They first explain the intuition through their models and confirm by empirical tests that product market rivals react to the high cash of other firms by holding less, especially for firms that face greater competition. This is because high cash induces more efforts of firms in innovation, which reduces the benefits of doing the same by rivals, therefore rivals hold less cash and less investments in innovation; this effect is stronger when firms share a similar market. Although large competition lowers the benefits of cash and deters cash holdings, financially constrained firms must rely on cash, thus they hold more cash and affect peers to hold less. On the contrary, unconstrained firms rely less on cash holdings, they hold less cash considering the decreased returns on cash due to competition.

Particularly, the effect of cash holdings is stronger when there are negative effects of liquidity shocks. Schroth and Szalay (2009) explain that financing constraints increase the marginal costs of external financing on innovation, that is, the more innovation funded externally, the more costly the external capitals are, accordingly firms decrease innovation. However, the model predicts cash holdings help to mitigate the negative effects. Specifically, multinomial logit regressions indicate firms with more cash, or if their rivals held less cash, they are more likely to stand out in innovation competition.

Duchin et al. (2010) delineate the effects of the 2008 financial crisis on corporate investments (including capital expenditures, SG&A (selling, general and administrative expenses), R&D, net working capital and inventory) and how cash holdings play a part in this relation. The 2008 financial crisis features shocks to the supply of credit in the early stage and demand shocks (changes in growth opportunities) in the later stages. Difference-in-difference tests illustrate that in the early stage, firms cut investments sharply due to the unavailability of external financing, while cash holdings help to reduce the negative effects on investments. The negative effect of the financial crisis and the effect of cash holdings is stronger for financially constrained firms and firms that rely on external financing more. Firms reduce investments even more if they have high net short-term debt or long-term debt that matures soon. Additionally, investments during the financial crisis are also actively responding to an increase in excess cash. The market reacts to this increase in investments

during the crisis positively, firms thus earn higher returns. In the later stage of the crisis, firms cut investments in response to reduced investment opportunities, and there are no significant relations between cash and investments.

Almeida, Campello, Laranjeira, and Weisbenner (2012) demonstrate how the interaction between debt maturity and supply of credit affects corporate investments. Through difference-in-difference tests based on the event of financial crisis, they show firms with long-term debt maturing at the beginning of the crisis decrease their investments, because these firms are unable to refinance with contraction in credit supply and they must repay the debt. The more long-term debt that mature, the more investments firms cut in response. On the contrary, firms that do not have debt maturing slightly increase their investments. Further analysis confirms it is the changes in the supply of credit that drive the negative relation between long-term debt maturity and investments. Moreover, firms cover debt repayments through cash holdings, inventory, and payout cuts, especially repurchases.

Brown and Petersen (2015) illustrate firms adjusted cash holdings and investments during the 2008 financial crisis. Most firms that engage in both innovation and capital expenditures choose to use cash to buffer R&D in the period that credit supply is cut. In other words, the reduction in capital expenditures is much higher than the reduction in R&D for most firms, especially during the most severe time of the financial crisis. Consequently, firms that rely on external financing are affected the most and display the strongest propensity for buffering R&D with cash. Without innovation, firms actively use cash to fund capital expenditures. The findings suggest that the importance of R&D outweighs fixed investments significantly because of the greater adjustment costs involved with innovation, such as employment costs and costs of potential leaks of intellectual properties.

H.-C. Chen et al. (2018) investigate financially constrained firms and explore the effect of cash holdings in exogenous shocks, i.e. the 2000 dot-com bubble and 2008 financial crisis, and the feedback effect of experiencing shocks. High cash holdings help constrained firms avoid costly external financing, these firms then increase capital investments and acquisitions, keeping dividend levels and excess returns unaffected during the two shocks. In contrast, low-cash or constrained firms are unable to increase investments and go through a significant drop in their excess returns. During the 2000 shock, default risks were great for both high and low-cash firms, but greater for high-cash firms, possibly because of pre-*Loss* long-term debt, which is the source of high cash. However, during the 2008 shock, low-cash firms were more likely to default. In turn, experiencing the 2000 shock encouraged small, highly levered, and illiquid firms to hold more cash, and help them lower default risks in the next downturn.

Malamud and Zucchi (2019) analyse how financing frictions at the aggregate level affect firm innovation and economic growth in a setting where both entrants and incumbents invest whilst facing financing constraints. The equilibrium implies the sensitivity of innovation to cash holdings of entrants is a downward slope, whereas that of incumbents fluctuates. This is because entrants hold large cash initially but hold less across time since their investments generate no revenues, and the cash flows of incumbents are unstable as a source of cash is unstable. Such financing frictions impede new entrants, which subsequently makes fewer threats to incumbents in competition, existing entrants make efforts to become incumbents. Economy growth thus benefits less from decreased entrants but more from incumbents. Moreover, economic growth depends on the trade-off between increases in the contribution of incumbents and reductions in the contribution of entrants and the entry costs. Low entry costs encourage entries, but financing frictions evict these entrants and reduce their investments, meanwhile increases in the investments of incumbents may not cover the reductions in new entrants. Conversely, high entry costs discourage entries and negative effects of financing effects on entrants are smaller, hence incumbents should make enough investments that offset the reduction in investments of entrants.

In all, current studies have shown growth opportunities and the concern over liquidity shortfalls increase firm cash holdings, and in turn, cash holdings enable firms to capture investments during negative shocks and outperform competitors.

1.3.3 Hypotheses Construction

Precautionary motive is an important determinant of cash holdings. Cash holdings can fund investments in case of a liquidity shortage. For example, exogenous shocks, such as contraction in credit supply and credit rationing, encourage firms to use cash holdings to fund investments. Like exogenous shocks, operation loss is another form of liquidity shortfalls. Operation loss can force firms to tap cash holdings too for daily activities other than expansion. Consequently, not all cash holdings will be available for investments. Investment sensitivity to cash holdings may change with reduced availability of cash holdings. And the firms' attitude towards cash holdings should determine how investment sensitivity changes.

As predicted by the static trade-off model, firms should have a target cash level that is optimal and maximizes shareholder wealth (Opler et al., 1999). Under this theory, there exists an optimal cash level that perfectly satisfy daily needs of firms, any cash that exceeds the optimal level is excess cash. Firms may expect optimal cash and excess cash to take

different roles in their liquidity arrangements. Opler et al. (1999) find that corporate investments are sensitive to optimal cash holdings but are insensitive to excess cash holdings, yet excess cash declines significantly with negative operating cash flows[4]. Firm financial officers explain that they use credit lines to fund investments, and do not have explicit plans for the use of excess cash (Lins et al., 2010). Therefore, when firms finance investments with optimal cash holdings, excess cash should act as a provisional remedy against negative shocks. If firms follow strictly different rules of these two parts of cash, little change in investment-cash holding sensitivity should be expected. Because firms only use optimal cash to fund investments and use excess cash to cover negative shocks, changes in excess cash should not spill over into the use of optimal cash. It is also possible inadequate excess cash holdings force firms to use optimal cash holdings for extra support. Under the circumstances, investment-cash holding sensitivity should decline during operation loss.

However, it is likely that firms do *NOT* distinguish optimal cash and excess cash. The cash reserves are built for multi-purposes and firms prioritize the use for different purposes in good and bad times. Cash holdings are closely connected to investments. Firms can start years ahead of the expected time of using to save cash (Cunha & Pollet, 2019). This includes excess cash holdings. Harford (1999) find excessive cash holdings facilitate firm expansion, which results in empire-building problems. When shareholder powers are weak, excess cash induces even more capital expenditures and acquisitions (Harford et al., 2008; Hugonnier et al., 2014). Meanwhile, firms also use cash savings to make up for shocks. When there are cash flow shocks, cash holdings may decrease far below the optimal level, and at this time, investments should only be made with external financing (Hugonnier et al., 2014). When there are exogenous shocks to external financing, Duchin et al. (2010) show both total cash holdings and excess cash offset liquidity shortages. Hence, firms should see optimal cash and excess equally. They not only use cash holdings to meet current and future needs but also to cover shocks when shocks arrive.

On this occasion, changes in this sensitivity may be subject to two conditions. First, the magnitude of cash holdings. Almeida et al. (2012) find during the 2008 financial crisis where credit supply was restricted, firms must use at least 41% of their cash balance to cover the liquidity shock. It was likely firms did not have enough cash to satisfy all needs, or not enough to cover all needs persistently. Second, the importance of the needs that were originally fulfilled by external liquidity. As indicated by Almeida et al. (2012), firms appear to cut investments to preserve liquidity for other priority uses, such as daily operations.

[4] The reason that firms in the top quantile with most excess cash sink into the bottom quantile with least excess cash is experiencing negative operating cash flows (Opler et al., 1999).

Lemmon and Roberts (2010) suggest external financing was unlikely to be substituted with cash holdings during the financial crisis, corporate investments responding to declines in liquidity with equal reduction. Taken together, cash holdings first fund investments, but operation loss occupies cash holdings once it arrives. Thus, investment-cash holding sensitivity decreases during operation loss unless the cash reserve is large enough for all needs.

Hypothesis 1 Investment-cash holding sensitivity after operation loss decreases.

It is likely the saving and spending habits of firms decide post-crisis performance. Firm are better with more cash holdings to handle negative shocks (Duchin et al., 2010), so more cash holdings should reduce negative effects of operation loss on investment-cash holding sensitivity. Firms' saving and spending habits should decide the level of cash holdings. There can be two patterns of firms' saving and spending. First, a firm can save less cash but have more cash available when there are negative shocks. The low cash level of a firm may be for two reasons. Some firms cannot build cash reserves. Cash flows are the liquidity sources of both cash reserves and investments. Limited cash flows mean firms must choose between saving and spending. Prioritizing spending on investments or debt retirement leads to smaller cash holdings (Chang et al., 2014; Denis & Sibilkov, 2009). Some firms may not wish to hold large cash holdings. Access to low-cost external financing makes large cash holdings less necessary, a low cash balance also helps to reduce the cost of carry (Almeida et al., 2004). Despite low cash holdings, these firms do not use cash holdings until negative shocks occur.

Second, in contrast, a firm can save more cash but have less cash available when there are negative shocks. The high cash level of a firm can occur in three conditions. Some firms heavily rely on internal liquidity. The heavy reliance on cash holdings can be a result of fewer alternative fundings (Almeida et al., 2004; Moritzen & Schandlbauer, 2019). It can also be a result of severe competition, and cash holdings facilitate timely response to competitors' moves (Lyandres & Palazzo, 2016; Schroth & Szalay, 2009). Some other firms passively accumulate high cash. For instance, multinational firms. Multinational firms should prefer lower cash balances because they have access to international external financing other than domestic financing (Fernandes & Gonenc, 2016). However, foreign incomes of multinational firms are taxed when being shifted to the home country. This costly transfer of cash advocates firms to keep foreign incomes at foreign subsidiaries, which leads to high cash holdings (M. W. Faulkender et al., 2019). In addition, foreign cash holdings are

related to overinvestment overseas, which decreases cash holdings (Harford et al., 2017). Therefore, firms save more cash holdings and spend more cash holdings, there may be insufficient cash holdings left when shocks arrive.

Hence, low-cash firms show a low sensitivity of investments to cash holdings during normal times. In contrast, high-cash firms show a high sensitivity of investments to cash holdings, which makes high cash balances transitory. Contingent on operation loss, firms originally with high cash holdings cannot fulfil extra liquidity demands, they experience a larger decrease in investment-cash holding sensitivity. Firms originally with low cash may instead increase the sensitivity of investments to cash holdings.

Hypothesis 2 Investment-cash holding sensitivity after operation loss decreases if firms have more cash but increases if firms have less cash.

Financial constraints are an important factor affecting cash management. Financial constraints decide the ability of firms to finance externally and propensity for saving cash. Greater financially constraints limit firm access to external financing. Lenders can ration credit supply to constrained firms directly, or offering strict covenants that incur high costs and deter constrained firms from borrowing. Lack of external financing encourages financially constrained firms to use internal liquidity, which incurs a propensity for building large cash reserves out of cash flows. During economic downturns, the propensity for saving is further strengthened. Because downturns increase attractiveness of future investments, firms cut current investments to preserve liquidity for later use (Almeida et al., 2004). This cash saving behaviour of constrained firms persists, even when they have access to credit lines. The reason is the current availability of external financing does not guarantee the future because of refinancing risks (Harford et al., 2014).

However, a greater propensity for saving does not predict a higher cash balance. Cash flow is the source for many firm activities, such as corporate investments and cash holdings (Ağca & Mozumdar, 2017; Alti, 2003). Financially constrained firms prioritize saving cash and preserving debt capacity over investments among allocation of cash flows, while unconstrained firms perform the opposite (Chang et al., 2014). A constrained firm prioritizing investments ends up with reduced free cash flows and low cash holdings (Denis & Sibilkov, 2009). A constrained firm prioritizing cash savings and holding relatively large cash holdings may follow two routes subsequently. First, they consume the cash quickly through investments. As the main reason for cash saving is to help constrained firms seize valuable growth opportunities (Cunha & Pollet, 2019; Hoberg et al., 2014), it is likely the

cash holding will be exhausted before operation loss arises. Second, they show conservatism in spending amid shocks. During a financial crisis, constrained firms care more about future financing needs, they cut investments to save cash as current opportunities become less attractive (Campello et al., 2010), particularly when the future becomes less predictable (Friberg & Seiler, 2017).

Therefore, constrained firms either have fewer cash holdings to deal with negative shocks, or they have more cash that is only meant to be spent in the future. Constrained firms should have a weakened sensitivity of investments to cash holdings during operation loss regardless of the magnitude of cash holdings, whereas unconstrained firms experience fewer negative changes in the sensitivity of investments to cash holdings.

Hypothesis 3 Investment-cash holding sensitivity after operation loss decreases if firms are financially constrained firms but increases if firms are unconstrained.

Firm debt policy also interacts with cash policy. On the one side, debt and cash are substitutes, firms with more debt should have less cash holdings. Because a strand of the same factors affects debt and cash policies in opposite directions, leverage is significantly negatively related to excess cash holdings (Opler et al., 1999). Hence, as firms with little cash are highly likely to face immediate cash shortfalls, they borrow and spend the proceeds of debt issuance swiftly, with cash holdings remaining low (Rongbing Huang & Ritter, 2020). However, high debt level increases refinancing risks, which can curtail future liquidity sources. Potential future cash shortfalls urge currently highly levered firms to save cash out of cash flows (Harford et al., 2014). Except for cash flows, firms would rather save cash from proceeds of costly equity issuance than debt issuance to lower refinancing risks (Armenter & Hnatkovska, 2017). Consequently, firms do not save much cash if they use debt, or until they intend to use less debt in the future.

On the other side, debt retirement consumes cash holdings, firms that have more debt maturing soon should have less cash holdings available. As a (not entirely equal) alternative to cash holdings, firms can also preserve debt capacity, i.e. the ability to borrow in the future (Acharya et al., 2007). Preserving debt capacity indicates firms must retire debt, cash flow is one of the sources that pay down debt (Chang et al., 2014; Lewellen & Lewellen, 2016), whereas cash flow is also the source of other activities, especially corporate investments and cash reserves, more cash flows occupied by debt retirement imply less for cash holdings (Denis & Sibilkov, 2009). Additionally, cash holding itself is also a source of debt retirement. Firms actively adjust their cash-holding compositions by converting fewer liquid financial

instruments into pure cash to pay down debt (Cardella et al., 2021). When there is a financial crisis, contraction in credit supply forces firms to cut investments, and highly levered firms exhibit a greater level of reduction in investments to avoid default (Almeida et al., 2012; Duchin et al., 2010). Hence, for a firm that is about to pay down debt, it not only signals the firm has fewer cash holdings, but also suggests immediate debt retirement further reduces the cash holdings. Firms with debt repayment then should experience a larger negative change in the sensitivity of investments to cash holdings when there is an internal shock.

Hypothesis 4 Investment-cash holding sensitivity after operation loss decreases if firms have liabilities but decreases less if firms do not have liabilities.

Corporate governance (at both firm- and country-level) is an important determinant that shapes firm cash policies (Frésard & Salva, 2010; Harford et al., 2008; Pinkowitz et al., 2006). At country level, poor creditor rights result in costly external financing, firms have a greater propensity of holding cash (A. Dittmar et al., 2003). While firm-level corporate governance does not affect the accumulation of cash holdings (A. Dittmar & Mahrt-Smith, 2007), it affects how cash holdings are allocated, one specific issue is the free cash problem (Jensen & Meckling, 1976). Free cash problem or agency conflict refers to the event that executives who should maximize shareholder wealth instead extract private benefits from cash holdings. It occurs because inferior governance allows abusive use of executive power, cash holdings are spent on investments that decrease firm value but facilitate personal interests of executives. Free cash problem not only devalues the cash holdings (Frésard & Salva, 2010) but also leads to low level of cash holdings (Harford et al., 2008). Accordingly, despite poorly governed firms may display high investment sensitivity to cash holdings during good times because of free cash problem, they are unable to sustain the investments in hard times due to insufficient cash holdings.

In firms with good governance, shareholders can discipline management to protect their interests. Monitoring encourages cash distribution or profitable investments instead of wasteful spending. Well governed firms suffer less from the free cash problem and can stick to optimal cash levels (H. Chen, Yang, Zhang, & Zhou, 2020). Therefore, these firms should have more cash than poorly-governed firms (Harford et al., 2008), and more liquidity against shocks that should help to maintain a stronger sensitivity of investments to cash holdings.

Hypothesis 5 Investment-cash holding sensitivity after operation loss decreases if firms are poorly governed but increases if firms are well governed.

Geographical diversification can lead firms to accumulate either more (M. W. Faulkender et al., 2019; Gu, 2017) or fewer cash holdings (Fernandes & Gonenc, 2016). Being geographically diversified means firms operate internationally. On the one hand, Fernandes and Gonenc (2016) find multinational firms from different countries all hold less cash, as these firms are exposed to more external financing across their overseas operation locations, there is little need for precautionary cash due to low cash flow risks. On the other hand, although multinational firms may have less propensity for saving cash for the precautionary motive, unique to U.S. multinational companies, repatriation tax can encourage firms to save more cash. U.S. multinational firms hold cash overseas for repatriation tax but for the precautionary motive domestically (M. W. Faulkender et al., 2019). Because foreign incomes generated by foreign subsidiaries are not taxed until being shifted back to their parent companies, a large amount of tax makes the transfer of cash costly, which convinces firms to keep cash holdings overseas until tax is reduced. Consequently, multinational firms passively retain a surplus of cash overseas, eventually contributing to abnormally high total cash holdings, especially for innovative firms (M. W. Faulkender et al., 2019; Pinkowitz et al., 2015).

With rich discretionary cash, U.S. multinational firms overinvest in capital expenditures and acquisitions overseas but underinvest domestically. Wasteful spending devalues the foreign cash holdings, whereas such overinvestment and discount on cash value naturally evaporate once there is repatriation tax deduction (Hanlon et al., 2015; Harford et al., 2017). Moreover, foreign income increases both overseas and domestic investments in innovation. Despite the high costs of repatriation tax, foreign income is positively related to domestic R&D (Hanlon et al., 2015). This is because innovation is the most important among corporate investments (Brown & Petersen, 2015), and innovative multinational firms can transfer foreign income through intercompany transactions (M. W. Faulkender et al., 2019). Hence, although multinational firms have high foreign cash holdings, they overinvest overseas and only care about domestic innovation input due to repatriation tax, sensitivities of investments to cash holdings should be negatively affected by operation loss but to a smaller degree.

Hypothesis 6 Investment-cash holding sensitivity after operation loss decreases if firms operate domestically but decreases less if firms operate internationally.

1.4 Empirical Strategy

1.4.1 Data and Samples

The data comes from two sources, Compustat and Capital IQ. Compustat collects and presents financial and market information of listed firms worldwide, particularly U.S. and Canadian companies. Capital IQ contains a wider range of information, including financials, primary and secondary market transactions, credit ratings, and personnel, of both public and private firms. This chapter used accounting information from Compustat and data on credit lines from Capital IQ. The sample period covers from 1998 to 2019[5]. Following previous studies, financial firms, with SIC codes ranging from 6000 to 6999, and utility firms, with SIC codes ranging from 4900 to 4949, are excluded, since they are subject to regulatory requirements that can cause abnormally high cash balances. The sample also contains firms that are active in the sample period only. In addition, observations with missing values in any variables are excluded. Eventually, the sample in this chapter comprises 2,465 companies. And the sample contains 26,111 observations, which is close to the number of observations (26,421) of Duchin et al. (2010).

1.4.2 Variables and Measures

This chapter investigates how firms balance their cash allocation among their investment and operation loss, and the answers are available from tests on how operation loss affects investment-cash holding sensitivities.

The dependent variable is corporate investments, *Investment*. Following Lewellen and Lewellen (2016), corporate investments are beyond the single dimension of capital expenditures by also including acquisitions and R&D expenses. Hence, *Investment* is the sum of capital expenditures, acquisitions, and innovation deflated by net total assets. These investments are included for two reasons. First, capital expenditures are not the only investment sensitive to internal funds. According to Lewellen and Lewellen (2016), firm cash flows are strongly related to growth in a wide range of investments other than capital expenditures, such as acquiring patents, and the sensitivities of investments to cash flows vary across investment types. Firms may prefer certain investments with certain financing methods, focusing on one dimension can lead to either very strong or very weak links between investments and internal liquidity. Therefore, a relatively inclusive measure of corporate investments may help to balance such variation. Second, sway in investment focus. Innovation becomes increasingly more important in firm investments and is attributed as the

[5] The initial dataset starts from 1989, with observations before 1998 are removed due to disqualification in preliminary processing of data.

major factor driving the increase in cash holdings (Bates et al., 2009; Begenau & Palazzo, 2020; He & Wintoki, 2016; Lyandres & Palazzo, 2016), even for trapped foreign cash (Hanlon et al., 2015; Pinkowitz et al., 2015). There are several reasons why R&D-intensive firms show a greater preference for cash. First, most of their assets are intangible and less informative, high information asymmetry inflates the costs of capital. Second, innovative firms do not generate cash flows until the initial input is translated into real products, and the cash flows are unstable. Third, the discontinuity of innovative projects due to the unavailability of liquidity is costly. Firms may face costs related to the dismissal of highly skilled employees, proprietary information leaks, and loss in the competition, which is less relevant to capital expenditures (Almeida & Campello, 2007; Bates et al., 2009; Brown & Petersen, 2011, 2015; He & Wintoki, 2016; Lyandres & Palazzo, 2016). This trend for cash is not limited to relatively newly built and high intangibility R&D-intensive firms that almost entirely focus on innovation (Bates et al., 2009), but also applies to existing firms, whose financial policies react to innovation more strongly in recent decades (He & Wintoki, 2016). To address the trend for innovation, firm R&D expense is included as a part of the corporate investment measure.

Inspired by Hugonnier et al. (2014), who theoretically consider cash serves operating loss, this chapter defines the first key independent variable as operation loss, i.e. *Loss*, an indicator that equals 1 if firms have negative operating cash flows, otherwise it is zero. Operating cash flows are specified by the Compsustat item *oancf*, which reports all net changes in cash flows from operating activities on the statement of cash flows[6]. This item is rarely explored in existing literature. From the accounting view, it distinguishes operating cash flows from financing and investment cash flows. Since the dependent variable is corporate investments, the exclusion of investment cash flows prevents contamination of firm investment activities that may cause endogeneity. The exclusion of financing cash flows isolates external financing, with the inclusion of broad firm liquidity sources such as accounts receivable, *oancf* should address the changes in ability of firms to generate internal funds.

Another key independent variable is *Cash*, which is firm cash holdings. Following the common measure of cash holdings in existing studies, *Cash* is the ratio of cash and cash equivalent (*che*) over net total assets (*at-che*), which represents the firm ability to generate

[6] According to the description of Compustat, *oancf* contains twelve items, including accounts payable and accrued liabilities (*apalch*), accounts receivable (*recch*), assets and liabilities (*aoloch*), deferred taxes (*txdc*), depreciation and amortization (*dpc*), equity in net loss (*esubc*), extraordinary items and discontinued operations (*xidoc*), funds from operations (*fopo*), income before extraordinary items (*ibc*), income taxes (*txach*), inventory (*invch*), sale of PP&E and investments (*sppiv*).

profits as a function of asset-in-place (Opler et al., 1999). Some studies challenge the traditional measure of precautionary cash holdings. For instance, according to a survey targeting corporate CFOs (Lins et al., 2010), firms that have the highest cash ratios do not typically have the highest non-operational cash, instead, firms that ranked in the middle by cash ratios are more inclined to hold largest non-operational cash balance out of precautionary motive. Meanwhile, avoiding repatriation tax accumulates high cash for multinational firms. Gu (2017) finds that repatriation tax is the most important factor that drives the difference in cash ratios between domestic and multinational firms. Likewise, M. W. Faulkender et al. (2019) conclude that increases in trapped cash overseas account for the rapid growth in total cash holdings of multinational firms, and the precautionary motive only explains cash held domestically. Almeida et al. (2014) emphasize that a large proportion of cash holdings in multinational firms remain overseas, the measure of cash holdings contains foreign cash that is not available for domestic use. Therefore, total cash may not properly measure precautionary cash. Nonetheless, both Lins et al. (2010) and M. W. Faulkender et al. (2019) later suggest total cash ratio is reliable to measure precautionary cash. This issue is addressed in the following discussion.

The model controls a strand of variables for firm idiosyncratic effects. First, following Duchin et al. (2010), Tobin's Q (Q) and cash flow (*Cash Flow*) are included to control firm growth opportunities. According to Alti (2003), Q is better at forecasting distant future opportunities, while cash flows measure near-term investment opportunities. The Q is constructed based on market price (Ağca & Mozumdar, 2017; Bolton, Chen, & Wang, 2011) and *Cash Flow* by the traditional measure, i.e., the income before extraordinary items plus depreciation and amortization (EBITDA). However, since *oancf* contains information about depreciation and amortization, cash flow is also measured by earnings before interest and taxes (EBIT) (Gu, 2017). Firm size (*Size*) and leverage (*Leverage*), which are computed as natural logarithms of the book value of assets and debt-to-sales ratio respectively, are controlled according to (Opler et al., 1999). Moreover, the model also takes payout policies into account. *Dividend* is included as a binary variable that equals one when firms pay dividends or repurchase shares, otherwise equals zero. Firms are likely to retain cash holdings instead of distribution to fund investments when liquidity is scarce, such as in a financial crisis (Bliss, Cheng, & Denis, 2015). Finally, the sample excludes any observation that has missing values in the variables mentioned above.

1.4.3 Model Specifications

To test the hypotheses, this model considers corporate investment as a function of cash holdings and firm characteristics by following those who investigate the sensitivities of investments to liquidities (Alti, 2003; Denis & Sibilkov, 2009) and a function of operation loss by following those who investigate the effects of negative shocks on investments (Duchin et al., 2010). The baseline model specifies as:

$$Investment_{i,t}=\alpha+\beta_1 Cash_{i,t}+\beta_2 Loss_{i,t}+\beta_3 Cash_{i,t}\times Loss_{i,t}+\beta_4 X_{i,t}+fe_{i,t}+\varepsilon_{i,t} \quad (1\text{-}1)$$

Where *Investment* is the dependent variable, the two main independent variables are *Cash* and *Loss*. *X* stands for control variables. And *fe* represents year and firm fixed effects. So β_1 measures the investment sensitivity of cash, which means how cash affects investments, β_2 measures the investment sensitivity of loss, and β_3 is the parameter of interest, which measures the investment sensitivity of investments to cash holdings after being affected by operation loss.

1.4.4 Descriptive Statistics

Table 1-1 presents the descriptive statistics of the sample for the period from January 1989 to December 2019. On average, the annual corporate investments to firm *net* total assets ratio is 0.85, where capital expenditures explain a small fraction of 6.3%, slightly lower than the 8.9% of Lewellen and Lewellen (2016), but innovation expenses reach 76% of *net* total assets. Comparing with total assets, innovation accounts for 12% (unreported) of firm value, which is higher than the value of 8% (approximately) in extant studies (Brown & Petersen, 2015; He & Wintoki, 2016).

The entire sample has approximately 30% of observations experiencing operation loss[7]. Table 1-2 indicates that the high R&D expenses are driven by firms suffering operation loss, a ratio of 2.29 implies the investments in innovation are twice more than the firm *net* total assets, and the untabulated innovation expenses to the firm total assets ratio is 0.29. For firms that do not have operation loss, the innovation spending is much smaller, only 0.092 to *net* total assets and 0.044 (untabulated) to total assets, which is closer to the innovation to total

[7] After observations with R&D spending below the median are excluded, the numbers of observations with (6,483) and without (6,572) operation loss become close. This is possibly because the sample contains more non-innovative firms and innovative firms concentrate in the upper quantile (above the median) of R&D spending.

assets ratio of 0.05 of Malamud and Zucchi (2019). Relatively, both groups of firms spend less on capital expenditures than innovation. These variations are comparable to Brown and Petersen (2011), who show firms that invest in R&D allocate fewer resources on capital expenditures, especially young firms that input more in innovation than mature firms, and this gap increases aggressively across time. For example, during 1994-2006, Brown and Petersen (2011) suggest capital expenditures to total assets ratio of young and mature firms are 0.053 and 0.051, and R&D expenses are 0.195 and 0.067 respectively.

The gap between investments over *net* total assets and total assets implicates the sample firms hold huge amounts of cash holdings. The average cash-to-*net* total assets ratio is 1.99 and 0.28 (untabulated) to total assets, mostly caused by the firms with operation loss and large expenses on R&D. These firms hold a mean cash-to-net total assets ratio of 5.52, which potentially reflects the instability of R&D projects, as Malamud and Zucchi (2019) suggest that volatile cash flows generated by innovation investments lead to a fluctuated sensitivity of innovation projects to cash holdings. Conversely, firms without operation loss display a lower cash-to-net total assets ratio of 0.44, and a cash-to-total assets ratio of 0.19 (untabulated), close to the cash-to-total assets ratio of 0.202 of He and Wintoki (2016).

Generally, firms in the sample invest more in R&D and hold more cash than current studies. This is consistent with the explanation that firms become more interested in innovation and consequently prepare more cash for these intangible investments, as samples in this chapter cover a more recent period starting from 1989, which is a turning point for the surge in R&D expenses (Graham & Leary, 2018), Brown and Petersen (2011) also show young firms more than double their average cash holdings from 1994 to 2006 compared with the previous decade.

Additionally, firms with operation loss are smaller, have less access to debt financing, pay lower dividends, and face more growth opportunities (Q) than firms without operation loss, comparable to Brown and Petersen (2011), who find similar traits between young and mature firms

Table 1-1 Descriptive Statistics

This table reports the summary statistics for the key variables. The sample is constructed based on Compustat firms. The sample date ranges from January 1989 to December 2019. *Investment* is the sum of *capx*, *aqc* and *xrd* deflated by net total assets. *Cash* is cash holdings, measured by Compustat item *che* deflated by net total assets, *Loss* is an indicator variable representing operation loss, equals one if *oancf* is negative and equals zero otherwise. *Q* is Tobin's Q, calculated through market-based values. *Cash Flow* is income before extraordinary items plus depreciation and amortization scaled by total assets. *Size* is firm's size, measured by natural logarithm of total assets. *Leverage* is the ratio of short- and long-term debt over market value of common equity. *Dividend* is indicator variable, equal to one if the firm pays cash dividend or repurchases shares.

	(1) *Mean*	(2) *Median*	(3) *Std. Dev.*	(4) *Observations*
Investment	0.851	0.148	5.105	26,111
Capital Expenditures	0.0628	0.0386	0.0797	26,111
Acquisitions	0.0228	0	0.321	26,111
R&D Expenses	0.766	0.0461	5.103	26,111
Cash	1.993	0.214	11.64	26,111
Loss	0.307	0	0.461	26,111
Q	2.682	1.803	4.332	26,111
Cash Flow	-0.0918	0.0625	0.659	26,111
Size	5.948	5.883	2.304	26,111
Leverage	0.158	0.0849	0.198	26,111
Dividend	0.364	0	0.481	26,111

Table 1-2 Univariate Comparison

This table provides comparison of summary statistics between firms with and without operational loss. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Firms Without Operating Loss			*Firms With Operating Loss*			
	Observations = 18,105			*Observations = 8006*			*Difference in Mean*
	Mean	*Median*	*Std. Dev.*	*Mean*	*Median*	*Std. Dev.*	
Investment	0.183	0.114	0.452	2.361	0.482	9.014	-2.178***
Capital Exp.	0.0564	0.0391	0.0585	0.0774	0.0370	0.113	-0.021***
Acquisitions	0.0354	0	0.0831	-0.00566	0	0.564	0.041***
R&D Expenses	0.0916	0.0235	0.440	2.290	0.387	9.008	-2.198***
Cash	0.436	0.140	1.853	5.513	0.917	20.41	-5.077***
Q	2.252	1.714	2.007	3.653	2.198	7.123	-1.401***
Cash Flow	0.0872	0.0921	0.117	-0.496	-0.283	1.073	0.584***
Size	6.737	6.723	2.091	4.163	4.069	1.680	2.575***
Leverage	0.175	0.116	0.198	0.121	0.0249	0.192	0.054***
Dividend	0.461	0	0.498	0.145	0	0.352	0.315***

1.5 Empirical Results

1.5.1 Baseline Regressions

The baseline test examines hypothesis 1, whether the investment-cash holding relationship is affected by operation loss. Precautionary motive of cash holdings provides the liquidity when other resources are not available. For instance, corporate investments are sensitive to cash holdings during normal time where high costs and strict covenants discourage borrowing, or during bad time where shocks shrink credit supply (Cunha & Pollet, 2019; Duchin et al., 2010; Fresard, 2010; Haushalter et al., 2007; Opler et al., 1999). Operation loss suggests a weakened ability to produce cash flows, which highlights immediate internal liquidity shortfalls, and such idiosyncratic shocks can further restrict external financing (Minton & Schrand, 1999). When experiencing operation loss, a firm relying on cash holdings to make investments must withdraw more cash holdings to mitigate negative impacts of operation loss. However, in the context of an exogenous shocks to external financing, firms eventually decrease corporate investments because limited cash holdings cannot fully mitigate the negative effects of exogenous shocks (Campello et al., 2010; Duchin et al., 2010; Lemmon & Roberts, 2010). Likewise, cash holdings may not be able to entirely cover operation loss, which causes decreases in corporate investments, too.

The test results from equation (1-1) are presented in Table 1-3. Consistent with the expectations, column 1 indicates the positive relationship between cash holdings and corporate investments at the general level, one standard deviation increase in cash holdings contributes to a rise of around 1.87% in corporate investments on average. In contrast, operation loss is negatively related to investments, firms with operation loss decrease corporate investments by 0.21%, adhering to the view that firms cut investments when facing shocks (Duchin et al., 2010).

The coefficients of the interaction between cash holdings and operation loss, which measures investment-cash holding sensitivity under operation loss, are significantly lower than that of *Cash*. It indicates the extent that cash holdings fund investment with operation loss, one standard deviation increase in cash holdings can allow cash holdings fund investments by 0.9%, which falls approximately 50% lower than firms that do not have operation loss. Therefore, in line with hypothesis 1 and studies indicate that cash holdings mitigate part of the effects of credit supply contraction (Almeida et al., 2012; Duchin et al., 2010), cash holdings are still able to fund investment amid operation loss but only remain a weak link. Hugonnier et al. (2014) suggest that firms should fund investments completely with external

financing, because cash holdings become insufficient after dealing with operation loss, and it is costly to reaccumulate cash to finance investments. However, external financing can be costly too because of operation loss. With limited external financing, firms have to cut investments unless they have enough internal funds (Almeida et al., 2012). Hence, with both limited internal and external financing, firms can forgo investments but keep core parts with cash holdings.

In column 3, lagged operation loss is added to equation (1-1). The results show that both past and current negative shocks decrease corporate investments significantly, consistent with the idea that the persistence of financial conditions affects firm plannings (Lewellen & Lewellen, 2016; Minton & Schrand, 1999; Sufi, 2007). However, the sensitivity of investments to cash holdings of firms without operation loss becomes smaller. Since the corporate investments measure contains a large fraction of innovation, firms likely sense future financing constraints can also shift investments from risky and illiquid R&D projects to safe and liquid ones (Almeida et al., 2011), which leads to a lower coefficient. The interactions advise that firms experiencing both current and past operation loss maintain a lower but stable investment-cash holding sensitivity. In columns 2 and 4, the cash flow proxy that controls growth opportunities is computed by earnings before interests and taxes (EBIT), the results are robust.

Nonetheless, the lower sensitivity of investments to cash holdings for firms with operation loss fits both theories in hypothesis 1. That is, firms distinguish excess cash from optimal cash and expect excess cash to cover operation loss, but only to find excess cash is too small against negative shocks. According to Lins et al. (2010), the median firm excess cash holdings consist of only 2% of firm assets, although median total cash holdings can reach 10% of firm assets. Firms thus draw down optimal cash to remedy operation loss and incur the decline of investment sensitivity to cash holdings.

Alternatively, firms do not strictly distinguish optimal cash from excess cash. As the effective sample of Lins et al. (2010) contains only 204 big firms, their statements about distinctions between optimal cash and excess cash may not be representative enough. Instead, total cash holdings serve both operation loss and investments but with priority (Hugonnier et al., 2014). After covering operation loss, investment sensitivities to cash holdings decline due to insufficient cash holdings.

To understand the stories, a 2SLS strategy is adopted. In the 2SLS framework, firm optimal and excess cash holdings are estimated through the model (1-2) first, then corporate investment is regressed on the estimated optimal cash and excess cash by the model (1-1). Following Duchin et al. (2010), the model (1-2) consider cash holdings as a function of firm

size, cash flows, net working capital, industry cash flow volatility, and a year dummy variable[8]. Excess cash is the difference between estimated optimal cash and observed cash holdings.

$$Cash_{i,t}=\alpha+\beta_1 Size_{i,t}+\beta_2 Cash\ Flow_{i,t}+\beta_3 NWC_{i,t}+\beta_4 M/B_{i,t}+\beta_5 ICFV_{i,t}+Year \quad (1\text{-}2)$$

The results are given in Table 1-4. In the column 1 of Table 1-4, it is apparent that investment sensitivity to optimal cash is significantly higher, but marginally high to excess cash, consistent with Opler et al. (1999) who find investments respond differently to the optimal cash and excess cash. However, for firms with operation loss, there is no remarkable difference between optimal cash and excess cash. The interactions indicate firms still react to optimal cash more strongly, and no evidence suggests excess cash absorbs more effects of operation loss. Accordingly, based on the samples of this chapter, on average, firms may set target cash levels, but they do not separate excess cash. Hence, firms would rather arrange cash holdings according to the urgency of use, they allocate more cash towards investments during good times, but to shocks in difficult times.

Overall, the results echo hypothesis 1. It advises that the relations between investments and cash holdings are weakened by operation loss. Precautionary cash saved for investments is used to remedy negative shocks and is unable to fully cover shocks.

[8] This chapter seeks a boundary that isolates optimal cash holdings from excess cash holdings, where the boundary is proxied by the estimated single optimal cash level from model (1-2). It is likely that some firms may have an optimal cash range as an optimal leverage range some firms have (Leary & Roberts, 2005). However, this should not become a concern since there has no existing literature relying on a single optimal cash level raised such issues (Anderson & Carverhill, 2011; Duchin et al., 2010; Frésard & Salva, 2010; Gao, Harford, & Li, 2013; Harford et al., 2008; W. Huang & Mazouz, 2018; Kalak, Goergen, & Guney, 2020).

Table 1-3 Investment-Cash Holding Sensitivities and Operation Loss: Baseline Regressions

This table reports the regression estimation of the investment sensitivities to cash holdings with and without operation loss. The dependent variable is *Investment* (*capx + aqc + xrd)*/(*at - che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Columns 1 and 2 report the estimation without controlling lagged operation loss. Columns 3 and 4 report the estimation with controlling lagged operation loss. Columns 1 and 3 controls long-term investment opportunities using *Cash Flow* (*EBITDA*). Columns 2 and 4 controls long-term investment opportunities using *Cash Flow* (*EBIT*). All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
Investment (*Dependent Var.*)		*Full Sample*		
Cash	0.161***	0.156***	0.149***	0.143***
	(0.0158)	(0.0158)	(0.0184)	(0.0185)
Loss	-0.209***	-0.158**	-0.260***	-0.201***
	(0.0791)	(0.0794)	(0.0726)	(0.0728)
$Loss_{t-1}$			-0.241***	-0.239***
			(0.0724)	(0.0728)
*Cash*Loss*	0.0773***	0.0817***	0.130***	0.133***
	(0.0158)	(0.0158)	(0.0146)	(0.0147)
$Cash*Loss_{t-1}$			0.124***	0.125***
			(0.0164)	(0.0165)
Control Variables	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	26,111	26,111	23,152	23,152
R^2	0.319	0.312	0.498	0.493

Table 1-4 Investment-Cash Holding Sensitivities and Operation Loss: Optimal and Excess Cash
This table reports the regression estimation of investment sensitivities to optimal and excess cash holdings with and without operation loss. The dependent variable is *Investment* (*capx + aqc + xrd)*/(*at - che*). The independent variables are *Optimal Cash* (*estimated by equation (1-2)*), *Excess Cash* (*Cash – Optimal Cash*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Column 1 reports the estimation with including both optimal and excess cash holdings in the regression. Column 2 reports the estimation with including optimal cash holdings only. Column 3 reports the estimation with including excess cash holdings only. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
Investment (*Dependent Var.*)		*Full Sample*	
Optimal Cash	1.505***	1.730***	
	(0.552)	(0.660)	
Excess Cash	0.162***		0.176***
	(0.0161)		(0.0150)
Loss	-0.238*	-0.269*	0.0257
	(0.126)	(0.151)	(0.0854)
*Optimal Cash*Loss*	0.0817***	0.0770**	
	(0.0303)	(0.0339)	
*Excess Cash*Loss*	0.0757***		0.0616***
	(0.0161)		(0.0150)
Control Variables	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
Observations	25,825	25,825	25,825
R^2	0.319	0.022	0.319

1.5.2 Impacts of Size of Cash Holdings

Previous sections have shown that after experiencing operation loss, firms show lower investment-cash holding sensitivities, because firms do not have enough liquidity to cover both operation loss and existing investments, they must cut investments with lower priority. Therefore, it is likely cash-rich firms can finance investments whilst covering operation loss and outperform cash-poor firms.

Presumably, more cash balance can resist more negative effects of shocks. In a recession such as a financial crisis when credit supply is contracted or a sluggish market, firms with more cash present greater competency, they can smooth investments with cash holdings, gaining more market shares and facing smaller likeliness of bankruptcy (H.-C. Chen et al., 2018; Duchin et al., 2010; Haushalter et al., 2007). Therefore, after operation loss, high cash holdings should allow firms to take more investments, but low cash firms exhibit reduced sensitivities of investments to cash holdings compared with the pre-shock level.

However, hypothesis 2 assumes that firms holding more cash do not necessarily suggest that they would have more cash available at the time when operation loss occurs, as their saving habits are different. Some firms only hold large transitory cash holdings, they burn cash quickly on investments and leave no remains for other use. For instance, in newly founded R&D-intensive firms, which have high initial cash holdings initially and low continuous cash inflows, both their cash balance and the sensitivity of innovation investments to cash decrease across time (Malamud & Zucchi, 2019). While small, young firms show a greater propensity for saving cash out of cash flows, they have fewer cash holdings because limited cash flows do not allow large cash retention (Denis & Sibilkov, 2009), or they forgo current investments to build cash reserves but quickly burn the money for subsequent investments (Chang et al., 2014). Additionally, increases in cash flow facilitate more liquid investments and lower costs of external financing, financially constrained firms may choose not to save (Almeida et al., 2011). Big, mature firms save less cash because of access to external financing is available (Almeida et al., 2004), and access to efficient internal capital markets if they were well-diversified (Duchin, 2010). Better financing makes them better at handling negative shocks (Duchin et al., 2010). Hence, low-cash firms that do not spend cash holdings have more cash holdings available than high-cash firms with high cash spending during operation loss. Low-cash firms thus may grow their investment sensitivity to cash holdings, whereas firms with initial high cash should see declines.

In Table 1-5, the coefficient of cash holdings in column 1 shows a negative relation between cash holdings and investments for firms with less cash, which suggests these firms must

choose between investments and cash savings with limited cash flows, consistent with (Denis & Sibilkov, 2009). While the coefficient of cash holdings in column 2 suggests greater investment-cash holding sensitivities for cash-rich firms, one standard deviation increase in cash induces investments to rise by 1.84% (11.64*0.158). Meanwhile, both firms are hit by operation loss, but cash-rich firms suffer greater negative influences. Operation loss reduces corporate investments by 0.44% in high-cash firms and by 0.025% in low-cash firms.

Nonetheless, low-cash and high-cash firms appear to behave oppositely in the aftermath of operation loss. As shown in column 1, when there is operation loss, one standard deviation increase in cash holdings allows investments in low-cash firms to increase by 1.94 %, which is higher than the pre-shock level. Column 2 shows that high-cash firms only increase investments by 0.95% with one standard deviation increase in cash holdings, lower than pre-*Loss* level, also lower than low-cash firms. These findings are consistent with hypothesis 2 and saving/spending habits of cash have a large influence on how firms manage shocks. A firm tends to save large cash holdings but is also likely to spend more, which leads to lower cash available than low-cash firms in real needs. For example, a firm managed by an overconfident CEO is highly likely to hold more cash because of the reluctance of financing externally, aggressive spending eventually depletes the cash holdings and make them become cash-poor firms (Deshmukh, Goel, & Howe, 2021). Alternatively, according to Denis and McKeon (2021), some firms with negative net cash flows exhibit saw-toothed patterns of cash holdings, because they repeatedly save cash from equity issuance and spend immediately. Despite the higher costs, firms save cash from equity issuance when internal liquidities are insufficient, especially for small firms (Graham & Harvey, 2001). Conversely, a firm that has low cash holdings only taps cash holdings in a crisis and can well manage the shocks. Especially, if these firms find both them and their rivals are in the same situation, but they have more cash, they may behave more aggressively to take advantage of their rivals' weaknesses to win the competition (Fresard, 2010; Schroth & Szalay, 2009). Furthermore, the increased sensitivity of investments to cash holdings in low-cash firms confirms that the adjustments are not because of signals about investment quality from cash flow shocks (Alti, 2003), but out of strategic considerations.

Column 3 gives the *p*-values of cross-sectional difference of main variables. The result suggests that the pre-*Loss* sensitivity of investments to cash holdings are cross-sectionally significantly different, and operation loss brings different levels of negative effects on corporate investments. However, the investment sensitivities to cash holdings after operation loss between low and high cash groups are statistically insignificant. This may indicate that

amid operation loss, low and high cash firms adjust their investment sensitivity to cash holdings to a similar level.

In all, consistent with hypothesis 2, crisis handling ability is associated with the pre-*Loss* investment-cash holding sensitivity. Firms that spend more before negative shocks mean there is less cash left for post-*Loss* investments, which leads to lower investment-cash holding sensitivities.

Table 1-5 Investment-Cash Holding Sensitivities and Operation Loss: Size of Cash Holdings

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by the size of cash reserves. Firms are partitioned into low (*Low Cash*) and high cash (*High Cash*) groups by the median. The dependent variable is *Investment* (*capx + aqc + xrd*)/(*at - che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Column 1 reports the estimation of low cash firms. Column 2 reports the estimation of high cash firms. Column 3 reports the *p*-values for the difference in the coefficients of *Cash*, *Loss* and *Cash*Loss* between low and high cash firms. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
Investment (*Dependent Var.*)	*Low Cash*	*High Cash*	*p-values*
Cash	-0.0813***	0.158***	0.000
	(0.0211)	(0.0233)	
Loss	-0.0250***	-0.439***	0.0025
	(0.00461)	(0.161)	
*Cash*Loss*	0.167***	0.0815***	0.494
	(0.0438)	(0.0233)	
Control Variables	Yes	Yes	
Year & Firm Fixed Effects	Yes	Yes	
Observations	13,061	13,050	
R^2	0.220	0.327	

1.5.3 Impacts of Financial Constraints

This part tests hypothesis 3, how investment-cash holding sensitivities amid operation loss vary across financial constraints. Financial constraint measures the financial conditions that restrict firm behaviour. Financially constrained firms show a great propensity for saving by demonstrating a higher cash sensitivity to cash flows, especially for investments (Almeida et al., 2004) due to restricted access to external financing, which is expressed as higher costs of borrowing or rationing by lenders. A firm that has limited access to external financing can be result of a lack of pledges to guarantee debt repayments (Lian & Ma, 2020; Nikolov, Schmid, & Steri, 2019). Such pledges can be collaterals or firm cash flows. Interestingly, a small cash flow that restricts firms to access external financing also limits their ability to build large cash reserves (Denis & Sibilkov, 2009). Constrained firms must rely on internal resources to meet liquidity needs. Therefore, a greater sensitivity of investments to cash holdings can be expected for financially constrained firms without operation loss. However, heavily relying on cash holdings for current needs can contribute to insufficient resources for the future, with no additional funds from outside, this lack of financial freedom contributes to an inferior crisis management. Like high-cash firms, constrained firms are more likely to reduce their investment-cash holding sensitivities.

On the flip side, there is a positive relation between cash holdings and investments for unconstrained firms, too, when there is no operation loss. This is because unconstrained firms can generate higher cash flows and they can save more cash to finance investments, even if they do not intend to. The average net cash ratio (*Cash*) of sample firms is 3.67 if they are constrained and is 0.50 if they are unconstrained[9]. However, unconstrained firms hold an average absolute cash holding (*che*) of 672.44 million, whereas constrained firms hold only 181.70 million. Previous literature does not find unconstrained firms have the propensity for saving out of cash flows, although they do when there are clear and specific investment opportunities (Cunha & Pollet, 2019). However, this connection should be weak for unconstrained firms since they are more likely to use external financing. Since unconstrained firms have more cash holdings and they do not heavily rely on cash holdings for daily activities, they will have more cash left when an operation loss occurs. Therefore, like low-cash firms, unconstrained firms are expected to increase investment-cash holding sensitivities compared with the pre-*Loss* level and compared with constrained firms.

Three methods of financial constraint criteria are considered given data availability: SA

[9] Firms are sorted into constrained and unconstrained groups based on SA index, which this chapter discusses below.

Index, WW Index and if the firm has access to credit lines by Sufi (2007).

SA Index: some early studies use firm age and size separately to evaluate constraints, such as in Almeida et al. (2004), whereas the SA Index measures both dimensions in one indicator according to Hadlock and Pierce (2010), where firm age is the number of years that the firm goes public, and firm size the natural logarithm of total assets. The sample firms are divided into two groups by ranking them based on the median each year during the sample period. Firms in the bottom group are unconstrained and the top group is where the constrained ones are.

WW Index: KZ index and WW index are both employed widely in existing studies, while (Hadlock & Pierce, 2010) cast doubts on their effectiveness. They measure financial constraints based on textual analysis of firm filings, ordered logit tests using the qualitative-based constraint to be regressed on the same composition of the KZ index and WW index, and the direction of most variables is opposite to that in the computation of the index. Comparatively, the KZ index underperforms the WW index, and in some studies, such as Almeida et al. (2004), the results under the KZ index always exhibit inconsistency, which also questions its validity. Therefore, considering the popularity of these two methods, the WW index is used in the following tests. The WW Index is constructed by following Whited and Wu (2006). Firms are partitioned into two groups by median each year. Firms at the bottom are unconstrained firms otherwise they are constrained.

Sufi: Finally, this section uses credit lines as a measure of external financing, as suggested by (Campello et al., 2011; Disatnik et al., 2013; Sufi, 2007), cash holdings and credit lines are equal in a way. This chapter introduces the financial constraint method featuring credit lines proposed by (Sufi, 2007). A firm to be considered unconstrained must satisfy two conditions. First, its cash flow is above the median every year during the sample period; second, it must have access to credit lines every year during the sample period, and this chapter define “having access to credit lines” as a firm’s used credit line is above zero. As financial constraints measure whether a firm has access to external financing, one prominent feature of this method is that it allows us to see whether a firm is restricted from external funds by investigating the usage of credit lines. Particularly, a line of credit is a monitored facility, financial intermediations can directly tell if a firm is denied from borrowing.

Consistent with hypothesis 3 and studies on financial constraints and investment-cash holding sensitivities (Alti, 2003; Denis & Sibilkov, 2009; Lewellen & Lewellen, 2016), the results in Table 1-6 show cash holdings are strongly and positively related to investments in all firms, especially for financially constrained firms. For example, in column 1, one standard deviation increase in cash holdings increases investments by 2.41%. However, the

coefficients of interactions between *Cash* and *Loss* show that investment-cash holding sensitivities decline among constrained firms and rise in unconstrained firms. In column 1, one standard deviation increase in cash holdings can only finance investments in constrained firms by 0.71%, but in column 2, unconstrained firms increase their investments by 1.44% with one standard deviation increase in cash. Although column 3 finds that the coefficients are not statistically significant in cross-section, the results confirm that financially constrained firms must decrease their investments financed by cash holdings, consistent with (Campello et al., 2010).

Additionally, from the results in columns 5 and 6, constrained firms without credit lines rely more on cash holdings during good times, they burn cash quickly and leave insufficient cash during bad times. Conversely, unconstrained firms with access to credit lines rely less on cash holdings during good times and have greater sensitivity of investments to cash holdings during shocks. Firms consider credit lines and cash holdings as substitutes to a certain extent (Acharya et al., 2013; Campello et al., 2011; Lins et al., 2010; Sufi, 2007). It reflects that although financially unconstrained firms are more likely to be affected by systemic risks, idiosyncratic risks can also affect their access to credit lines and make unconstrained firms to drawdown cash holdings (Harford et al., 2014), which suggests the importance of collateral and profitability on access to credit lines (Nikolov et al., 2019). Moreover, the increase in sensitivity of investments to cash holdings may also indicate that financing frictions benefit major market players by squeezing small firms like entrants out of competition (Malamud & Zucchi, 2019), since incumbents have internal liquidities but entrants do not. Panel B gives the *p*-values of cross-sectional difference of main variables, constrained and unconstrained firms are likely to adjust their investment sensitivity to cash holdings to a close degree.

Overall, compared with unconstrained firms without operation loss, unconstrained firms appear to perform a greater investment-cash holding sensitivity than previously when there is an operation loss, which reflects their better liquidity management, whereas constrained firms decrease their sensitivity of investments to cash holdings.

Table 1-6 Investment-Cash Holding Sensitivities and Operation Loss: Financial Constraints

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by financial constraints. Firms are partitioned into constrained (*Con.*) and unconstrained (*Uncon.*) groups by the *SA Index*, *WW Index* and *Sufi* credit lines access respectively. The dependent variable is *Investment* (*capx* + *aqc* + *xrd*)/(*at* - *che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). *Panel A* reports the main estimation. *Panel B* reports the *p*-values for the difference in the coefficients of *Cash*, *Loss* and *Cash*Loss* between constrained and unconstrained firms. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)
Investment	*SA Index*		*WW Index*		*Sufi*	
(*Dependent Var.*)	*Con.*	*Uncon.*	*Con.*	*Uncon.*	*Con.*	*Uncon.*
			Panel A Main Results			
Cash	0.207***	0.108***	0.134***	0.150***	0.112***	0.0345**
	(0.0328)	(0.00298)	(0.0159)	(0.0255)	(0.0106)	(0.0161)
Loss	-0.265	-0.0800***	-0.0232	-0.450***	-0.0559	-0.220***
	(0.221)	(0.0106)	(0.0749)	(0.139)	(0.0571)	(0.0350)
*Cash*Loss*	0.0614*	0.124***	0.00602	0.161***	-0.00110	0.214***
	(0.0328)	(0.00393)	(0.0157)	(0.0256)	(0.0107)	(0.0179)
Control Var.	Yes	Yes	Yes	Yes	Yes	Yes
Year &Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7424	7430	13,050	13,061	10,455	692
R^2	0.368	0.548	0.259	0.387	0.258	0.701
			Panel B p-values			
Cash		0.0486		0.0056		0.6017
Loss		0.0884		0.0389		0.4232
*Cash*Loss*		0.629		0.694		0.1953

Furthermore, financially constrained firms act like high cash firms that reduce investment-cash holding sensitivities after operation loss; whereas unconstrained firms increase their investment sensitivity to cash holdings like low cash firms, while constrained firms do not necessarily have high cash and unconstrained do not have to hold less cash, the next tests examine the joint effects of the size of cash reserves and financial constraints to differentiate the nuance between these two criteria. Particularly, constrained firms with high cash and unconstrained firms with low cash holdings can face shortages in both internal and external liquidity, which leads to stronger negative sensitivity of investments to cash holdings in shocks.

Firms are sorted into four groups, i.e., low and high cash financially constrained firms and low and high cash financially unconstrained firms and repeat regressions through equation (1-1). The results are given in Table 1-7. Panel A shows results for constrained firms and Panel B for unconstrained firms.

Generally, panel A indicates that for the constrained firms, the effects of the size of cash holdings dominate the effects of financial constraints, while panel B demonstrates that for unconstrained firms, the effects of financial constraints predominate. Suggested by columns 2, 4, and 6 in panel A show that high cash constrained firms decrease their investments, in columns 3 and 5, low cash constrained firms increase their investment sensitivity to cash holdings after operation loss, which implies the importance of cash reserves for constrained firms, as financial constraints predict that constrained firms should decrease investments.

As for unconstrained firms, generally both low and high-cash firms increase their investments after operation loss like what the financial constraints predict in section 4.3, except column 5 in panel B, which gives insignificant negative estimates. Therefore, the results indicate that the size of cash holdings is less important for unconstrained firms, they appear to substitute between internal and external liquidity (Almeida & Campello, 2010; Lins et al., 2010), and build transitory cash balances by external financing (Denis & McKeon, 2021), so unconstrained firms manage to keep their cash balances at low levels by burning cash through investments immediately.

Table 1-7 Investment-Cash Holding Sensitivities and Operation Loss: Joint Effects of Cash Size and Financial Constraints

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by the size of cash reserves and financial constraints jointly. Firms are partitioned into four groups, low cash constrained firms, high cash constrained firms, low cash unconstrained firms and high cash unconstrained firms. The dependent variable is *Investment* (*capx* + *aqc* + xrd)/(*at* - *che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). *Panel A* reports the estimation of constrained firms. *Panel B* reports the estimation of unconstrained firms. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)
Investment	*SA Index*		*WW Index*		*Sufi*	
(*Dependent Var.*)	*Low Cash*	*High Cash*	*Low Cash*	*High Cash*	*Low Cash*	*High Cash*
			Panel A Constrained			
Cash	0.0222	0.199***	-0.102***	0.142***	-0.112***	0.116***
	(0.0770)	(0.0398)	(0.0288)	(0.0245)	(0.0284)	(0.0172)
Loss	-0.0136	-0.542	-0.0446***	-0.0912	-0.0237***	-0.0923
	(0.0112)	(0.336)	(0.00665)	(0.162)	(0.00677)	(0.136)
*Cash*Loss*	0.0183	0.0707*	0.367***	-0.00247	0.158**	-0.00516
	(0.105)	(0.0397)	(0.0610)	(0.0243)	(0.0650)	(0.0174)
Control Var.	Yes	Yes	Yes	Yes	Yes	Yes
Year & Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,127	5,297	7,068	5,982	6,040	4,415
R^2	0.387	0.376	0.233	0.273	0.266	0.276
			Panel B Unconstrained			
Cash	-0.113***	0.108***	-0.0804**	0.129***	0.0481	0.0349
	(0.0348)	(0.00445)	(0.0323)	(0.0363)	(0.125)	(0.0258)
Loss	-0.0142	-0.158***	-0.00918	-0.784***	-0.0609	-0.292***
	(0.00893)	(0.0238)	(0.00655)	(0.273)	(0.0646)	(0.0714)
*Cash*Loss*	0.164*	0.128***	0.0132	0.183***	-0.902	0.211***
	(0.0878)	(0.00593)	(0.0654)	(0.0365)	(1.217)	(0.0299)
Control Var.	Yes	Yes	Yes	Yes	Yes	Yes
Year & Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4200	3230	5993	7068	452	240
R^2	0.054	0.588	0.172	0.390	0.149	0.816

1.5.4 Impacts of Debt Retirement

Debt can affect firm cash policies of saving and spending. Firms substitute cash with debt, more debt results in less cash holdings. For firms with little cash, borrowing is essential to avoid immediate cash shortages. Meanwhile, firms use up borrowed cash holdings immediately, which makes them retain little cash (Rongbing Huang & Ritter, 2020). For firms saving more cash, they may not use debt from the beginning to mitigate refinancing risk (Armenter & Hnatkovska, 2017), or they are currently using debt, but wish to be prepared for liquidity shortfalls due to refinancing risk (Harford et al., 2014). Debt retirement can also deplete cash flows and existing cash holdings. Cash flows provide liquidity to firms to pay down debt (Chang et al., 2014; Lewellen & Lewellen, 2016), while cash flows also fund investments, such multi-use makes cash flows less available to build cash reserves (Denis & Sibilkov, 2009). Likewise, cash holdings are also used to pay down debt, for instance, firms convert illiquid assets into cash for debt repayment (Cardella et al., 2021). Therefore, firms with recent debt repayment hold less cash because they use debt and the savings from debt issuance is transitory, and debt repayment can reduce existing cash holdings to a lower level. Accordingly, if firms have debt repayment due, they should decrease investments more than firms without debt payments in the near term.

To test the ideas, this section utilizes debt maturity by following Almeida et al. (2012) and separate firms into groups with and without debt retirement due in each year of the next five years. The results are provided in Table 1-8.

The estimates illustrate that investments in both firms with and without debt are positively related to cash holdings. Investments in firms with debts maturing soon are more sensitive to cash holdings, consistent with Rongbing Huang and Ritter (2020) who show firms save proceeds of debt issuance but spend immediately. Both firms with and without debt payments decrease their investment significantly when there is operation loss, especially the coefficient of the interaction in column 2 of Panel B suggests a reversed sensitivity of investment to cash holdings in debt-paying firms, although statistically insignificant. Firms with debt repayments due cut more investments to avoid default and distress costs, as suggested by (Graham & Harvey, 2001), investment decision-making is subject to idiosyncratic firm risks rather than project quality. Another plausible explanation is that firms do not cut investments, but complete the projects earlier by sacrificing long-term returns and project value, which typically occurs among equity-dependent firms in the oil industry, to enhance collateral value and facilitate debt refinancing (Gilje, Loutskina, & Murphy, 2020). Additionally, the results show that the negative effect of debt maturity on

cash holdings and investment relations is mainly limited in the most recent two years, and if debt matured in three years or later, firms even increase the investment sensitivity of investments to cash holdings. Panel C shows post-*Loss* sensitivity of investments to cash holdings are statistically insignificant, as operation loss may change investment sensitivity to cash holdings to the same level among firms with and without debt.

In sum, the results are consistent with the hypothesis 4 and extant literature (Almeida et al., 2012; Duchin et al., 2010), debt aggravates the effect of negative shocks on investment sensitivity to cash holdings.

Table 1-8 Investment-Cash Holding Sensitivities and Operation Loss: Debt Retirement

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by debt retirement status. Firms are partitioned into no debt due (*No Debt Due*) and with debt due (*With Debt Due*) groups by whether they have debt repayments due in each year of a five-years period yearly. A firm can be with debt due (*dd1 > 0*) in *Year 1* but has no debt due (*dd2 = 0*) in *Year 2*. The dependent variable is *Investment* (*capx + aqc + xrd*)/(*at - che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). *Panel A* reports the estimation of firms with no debt due. *Panel B* reports the estimation of firms with debt due. *Panel C* reports the *p*-values for the difference in the coefficients of *Cash*, *Loss* and *Cash*Loss* between firms with and with no debt due. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)
Investment (*Dependent Var.*)	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
			Panel A No Debt Due		
Cash	0.149***	0.144***	0.166***	0.157***	0.154***
	(0.0309)	(0.0292)	(0.0270)	(0.0253)	(0.0237)
Loss	-0.270	-0.285	-0.291	-0.272	-0.242
	(0.229)	(0.218)	(0.198)	(0.172)	(0.154)
*Cash*Loss*	0.0869***	0.0939***	0.0775***	0.0783***	0.0814***
	(0.0308)	(0.0291)	(0.0270)	(0.0253)	(0.0237)
Control Variables	Yes	Yes	Yes	Yes	Yes
Year & Firm FE	Yes	Yes	Yes	Yes	Yes
Observations	8791	9310	10,017	11,479	12,719
R^2	0.310	0.319	0.335	0.313	0.323
			Panel B With Debt Due		
Cash	0.277***	0.376***	0.130***	0.104***	0.0484***
	(0.0153)	(0.0135)	(0.0176)	(0.0168)	(0.0133)
Loss	-0.104***	-0.0147	-0.0938***	-0.0792***	-0.0440***
	(0.0366)	(0.0278)	(0.0259)	(0.0223)	(0.0112)
*Cash*Loss*	-0.0232	-0.149***	0.102***	0.119***	0.0821***
	(0.0153)	(0.0135)	(0.0176)	(0.0168)	(0.0133)
Control Variables	Yes	Yes	Yes	Yes	Yes
Year & Firm FE	Yes	Yes	Yes	Yes	Yes
Observations	16,231	13,181	12,456	11,146	9,652
R^2	0.414	0.561	0.602	0.629	0.529
			Panel C p-values		
Cash	0.344	0.0301	0.0275	0.0919	0.0172
Loss	0.570	0.6504	0.3446	0.151	0.175
*Cash*Loss*	0.984	0.910	0.340	0.590	0.560

1.5.5 Impacts of Corporate Governance

A series of studies have demonstrated that cash policies are affected by corporate governance at both the firm level and country level (Frésard & Salva, 2010; Harford et al., 2008; Pinkowitz et al., 2006). Firms with inferior governance are likely to suffer from free cash problems, managers would spend internal liquidity on investments that bring private benefits, which leads to low levels of cash holdings (Harford et al., 2008), and such wasteful spending decreases the value of cash holdings (Frésard & Salva, 2010). Consequently, investment sensitivity to cash holdings is usually high for firms with poor governance, but they must decrease the sensitivity in hard times as cash holdings are insufficient to support the high expense. Conversely, managers in firms with good governance are well-trained, and with reductions in agency costs, there will be more resources available to firms when there are negative shocks.

To examine the hypothesis 5, the tests following Harford et al. (2008), using insider ownership as the measure of firm level corporate governance. According to Harford et al. (2008), a high concentration of insider ownership exteriorizes free cash problems, as insiders will have more power to extract private benefits from shareholders.

The results are given in Table 1-9. The results show that when there is operation loss, firms that are well governed outperform firms that are poorly governed, as their sensitivity of investments to cash holdings becomes higher, whereas the poorly governed decrease the investment sensitivity. Consistent with the hypothesis 5, firms with good governance are better at cash management, as fewer firm assets are appropriated for personal purposes, and more liquidity is available when negative shocks occur. However, despite the significant within-group changes, the results are not statistically significant in cross-section. It is possible that corporate governance exerts more influences on qualities of investments.

Table 1-9 Investment-Cash Holding Sensitivities and Operation Loss: Corporate Governance

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by corporate governance. Firms are partitioned into good (*Good Governance*) and poor governance (*Poor Governance*) groups by insider ownership. The dependent variable is *Investment* (*capx + aqc + xrd*)/(*at - che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Column 1 reports the estimation of firms with good governance. Column 2 reports the estimation of firms with poor governance. Colum 3 reports the *p*-values for the difference in coefficients of *Cash*, *Loss* and *Cash*Loss* between firms with good and poor governance. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
Investment (*Dependent Var.*)	*Good Governance*	*Poor Governance*	*p-values*
Cash	0.154***	0.151***	0.241
	(0.0379)	(0.0465)	
Loss	-0.487**	-0.426*	0.691
	(0.206)	(0.236)	
*Cash*Loss*	0.239***	0.0967**	0.928
	(0.0380)	(0.0464)	
Control Variables	Yes	Yes	
Year & Firm Fixed Effects	Yes	Yes	
Observations	8564	6001	
R^2	0.475	0.301	

1.5.6 Impacts of Geographical Diversification

Geographical diversification contributes to differences in cash holdings. Mixed evidence shows that multinational firms can hold more cash than their domestic peers (M. W. Faulkender et al., 2019; Gu, 2017) or less (Fernandes & Gonenc, 2016).

On the one side, repatriation tax is one of the reasons why multinational firms hold large amounts of cash. High costs of shifting overseas income back encourage multinational firms to keep the income where it is earned. Firms consequently keep high cash overseas (M. W. Faulkender et al., 2019; Gu, 2017). On the other side, cash holdings of multinational firms are associated with overinvestment overseas, but underinvestment domestically (Hanlon et al., 2015; Harford et al., 2017), cash holdings can be depleted before shocks occur. Low cash holdings of multinational firms may also be a result of an efficient internal capital market and various funding resources, and large cash holdings are less needed when alternatives are accessible (Fernandes & Gonenc, 2016). If multinational firms have more cash than their domestic counterparts, and the cash holdings can be transferred efficiently through the internal capital markets, the investment-cash holding sensitivity should be less affected, whereas domestic-only firms should have less liquidity available, they must discontinue cash-supported investments.

Especially, Graham and Leary (2018) indicate the tax significantly explains the increase in cash between 2000 and 2017, since most of the sample fall in this period, this chapter next examines whether multinational firms are better at managing shocks. The domestic only firms are separated from multinational firms in the sample, a firm is a multinational firm if it reports foreign income. The results are given in Table 1-10.

The table implies both investments in domestic and multinational firms are positively related to cash holdings. Consistent with the hypothesis 6, operation loss forces domestic firms to forgo investments to save cash, while there are limited effects from operation loss of multinational firms, as the investment-cash holding sensitivity only shows mild declines. There is no increase in the sensitivity like previous sections, firms may waste cash overseas and do not deal with domestic shocks using foreign cash as advised by Harford et al. (2017). However, Hanlon et al. (2015) find foreign cash is positively related to domestic innovation, the mild decreases thus suggest multinational firms are very likely to shift a small proportion of foreign cash back to protect the investments. Otherwise, multinational firms may hold relatively more cash than domestic firms because they are larger and mature companies. Column 3 shows that in cross-section, the sensitivity of investments to cash holdings differs in pre-*Loss* period, but they potentially converge to a similar extent after operation loss.

Table 1-10 Investment-Cash Holding Sensitivities and Operation Loss: Geographical Diversification
This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by whether firms are multinational firms. Firms are partitioned into domestic (*Domestic*) and multinational (*Multinational*) groups by whether they report foreign incomes (*pifo*). The dependent variable is *Investment* (*capx + aqc + xrd*)/(*at - che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Column 1 reports the estimation of domestic firms. Column 2 reports the estimation of multinational firms. Colum 3 reports the *p*-values for the difference in coefficients of *Cash*, *Loss* and *Cash*Loss* between domestic and multinational firms. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
Investment (*Dependent Var.*)	*Domestic*	*Multinational*	*p-values*
Cash	0.160***	0.161***	0.0226
	(0.0166)	(0.0192)	
Loss	0.0462	-0.337***	0.0449
	(0.105)	(0.0913)	
*Cash*Loss*	-0.0625***	0.150***	0.458
	(0.0165)	(0.0192)	
Control Variables	Yes	Yes	
Year & Firm Fixed Effects	Yes	Yes	
Observations	3796	22,315	
R^2	0.451	0.370	

1.6 Endogeneity

To mitigate the reverse causality concern between cash holdings and corporate investments in operation loss, this section examines the results using a 2SLS framework, in which cash holdings are instrumented by firm asset tangibility in the first stage.

Asset tangibility is an important determinant of firm cash holdings. Firms with low asset tangibility, such as innovative firms with high levels of intellectual properties, are more likely to build large cash reserves (Bates et al., 2009; Begenau & Palazzo, 2020; Pinkowitz et al., 2015). In contrast, high degree of asset tangibility is associated with low cash holdings (Lei, Qiu, & Wan, 2018). Tangible assets are pledgeable, which increases availability of external financing (Almeida & Campello, 2007), firm demands for cash decrease. However, in a mature financial market where external financing are more accessible, tangible assets have less impacts on cash holdings (Lei et al., 2018).

Nevertheless, asset tangibility is unlikely to affect corporate investments. Fresard (2010) argue that there is no direct link between firm market expansion and asset tangibility but bridged by the firm cash holdings. Almeida and Campello (2007) earlier illustrate that tangible assets increases investment-cash flows sensitivity as tangibility allows borrowing, whereas tangible assets do not have effects on corporate investments[10]. Therefore, following Fresard (2010), this chapter employ asset tangibility as the instrumental variable for cash holdings.

The first stage model of the 2SLS test specifies as:

$$Cash_{i,t}=\alpha+\beta_1 Tangibility_{i,t}+\beta_2 Cash_{i,t-1}+\beta_3 Cash_{i,t-2}+\beta_4 Tangibility_{i,t}\times Loss_{i,t} +\beta_5 Cash_{i,t-1}\times Loss_{i,t}+\beta_6 Cash_{i,t-2}\times Loss_{i,t}+\beta_7 X_{i,t}+fe_{i,t}+\varepsilon_{i,t} \quad (1\text{-}3)$$

Where the independent variable $Cash_{i,t}$ is firm cash holdings, *Tangibility* is asset tangibility, proxied by the natural logarithm of firm property, plant, and equipment (Compustat item *ppent*). The model also includes cash holdings that are lagged one year and two years as instrumental variables. X contains all control variables from equation (1-1), fe is firm and year fixed effects and ε is the error term. Then the fitted values of cash holdings in equation (1-1) are used in the second stage.

The results are given in Table 1-11. Column 1 shows the results from equation (1-1) by using

[10] The empirical results indicate there is no significant association between corporate investments and asset tangibility, see Almeida and Campello (2007).

instrumented *Cash*, and column 2 shows the first stage estimation of equation (1-3). As indicated by column 1, corporate investment is positively related to cash holdings, and operation loss pulls the investments in the opposite direction. And the coefficient of the interaction between *Cash* and *Loss* is significantly lower than that of *Cash*, which suggests operation loss decreases the sensitivity of corporate investments to cash holdings. These results are consistent with previous conclusions. In column 2, the coefficient of asset tangibility is significantly negative, because tangibility enables greater access to external financing, firms hold less cash. The two lagged cash holding variables are positively related to current cash holdings. These results are consistent with the first stage estimation by Fresard (2010).

In all, the results presented here indicate that the conclusions are robust to instrumented cash holdings.

Table 1-11 Endogeneity: Instrumental Variable

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss from a 2SLS framework. The dependent variable in the column 2 is *Cash* (*che/(at - che)*). The independent variables in the column 2 are *Tangibility (ln(ppent))* and lagged cash holdings. Column 2 reports the estimation of the first stage regression where cash holdings are instrumented by asset tangibility. The dependent variable in the column 1 is *Investment* (*capx + aqc + xrd*)/(*at - che*). The independent variables in the column 1 are instrumented *Cash (obtained in the first stage)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Column 1 reports the main estimation. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)
Investment (*Dependent Var.*)	*Full Sample*	*First Stage*
Cash (Instrumented)	0.448***	
	(0.0268)	
Loss	-0.390***	
	(0.0881)	
*Cash (Instrumented)*Loss*	0.164***	
	(0.0253)	
Tangibility		-1.554***
		(0.0777)
$Cash_{t-1}$		0.220***
		(0.0367)
$Cash_{t-2}$		0.147***
		(0.0364)
Control Variables	Yes	Yes
Year & Firm Fixed Effects	Yes	Yes
Observations	20,515	20,515
R^2	0.538	0.603

1.7 Conclusions

Previous literature has examined how cash holdings are related to corporate investments during good or bad times. This chapter extends these works by focusing on changes in the investment-cash holding sensitivity when there is operation loss, i.e. operating cash flow disruptions. And this chapter investigates the changes fluctuates with firms' attitude towards cash holdings and their saving habits.

There are several findings. First, operation loss weakens investment-cash holding sensitivity. The post-*Loss* investment sensitivity to cash holdings drops significantly compared with non-loss status. Particularly, the patterns of changes in investment sensitivity to optimal cash and excess cash are the same. Optimal cash and excess cash are not assessed in a different way in a mean firm, firms instead allocate the cash according to priority in different situations. Second, the changes of post-*Loss* investment-cash holding sensitivity vary in cross-section. Operation loss increases the investment sensitivity to cash holdings among low-cash firms but decreases the sensitivity among high-cash firms because saving habits of low- and high-cash firms are different. Low-cash firms save less cash and barely tap the cash holdings, whereas high-cash firms save more and spend more, making large cash holdings transitory and unavailable during negative shocks. In a similar fashion, financially unconstrained firms and well-governed firms that follow the low-cash firm pattern increase their post-*Loss* investment-cash holding sensitivity. Constrained firms and poorly governed firms exhibit a reversed change. Other firms include non-debt paying firms and multinational firms that should have more cash left amid shocks experience smaller declines in the post-*Loss* investment-cash holding sensitivity, their debt-paying and domestic peers experience bigger backlash. The findings are robust to cash holding proxy instrumented by firm asset tangibility.

This chapter complements the literature on the precautionary motive of cash holdings, showing how effectively cash holdings work when there is operation loss. However, some aspects are not covered in this chapter. The focus of this chapter is the within-group changes in investment-cash holding sensitivity. For example, the observed increase in post-*Loss* investment-cash holding sensitivity among low-cash firms and decrease among high-cash firms. However, the post-*Loss* investment-cash holding of low- and high-cash firms are not statistically significant. This can suggest firms react to a same event in different directions, but their outcomes are coincidentally the same. There are no further answers, and the question is left for the future.

Chapter 2

2 The Value of Non-Cash Cash Holdings

2.1 Abstract

Chapter 2 focuses on the value of cash and cash equivalent and the value of short-term investments respectively. Common measure of cash holdings can be decomposed into a cash and cash equivalent component and a short-term investments component. These two components differ from each other in liquidity and returns. In the baseline where liquidity is more important, the value of cash and cash equivalent is higher than short-term investments. This effect holds after controlling needs for recent debt retirement. Conversely, the value of short-term investments becomes higher than cash and cash equivalent in firms with lower near-term liquidity needs, fewer financial constraints, and poorer governance, where liquidity is less concerned and high returns are welcome.

2.2 Introduction

Cash saving behaviour of firms is well documented in existing literature, popular explanations for this behaviour include precautionary motive (Opler et al., 1999), agency costs (Jensen & Meckling, 1976), repatriation tax (Foley, Hartzell, Titman, & Twite, 2007). Existing literature also estimate the benefits of building cash reserves, in other words, the real value of total cash holdings other than their face value (M. Faulkender & Wang, 2006; Pinkowitz et al., 2006). More recently, Cardella et al. (2021) analyse the composition of cash holdings and its determinants. The common measure of cash holdings (Compsustat item *che*) contains non-cash financial assets, such as corporate bonds and government debt, except pure cash. Firms actively change the compositions of cash holdings depending on their liquidity needs. In addition, Duchin et al. (2017) consider a broad concept of cash holdings, they include long-term investments and financial assets other than those that constitute cash holdings from the conventional view. By thoroughly probing the characteristics of these assets, they show roughly a quarter of cash holdings that are usually assumed risky as safe

assets, meanwhile, most of these risky assets can also be illiquid[11]. Cardella et al. (2021) consider that the value of cash holdings decreases with more non-cash financial assets. However, Duchin et al. (2017) suggest that it can be optimal for unconstrained firms with sufficient liquidity to hold illiquid non-cash financial assets for illiquidity premium. Therefore, this chapter distinguishes from previous literature in that it evaluates two compositions of cash holdings, namely the cash and cash equivalent component (cash hereinafter) and the short-term investments component (short-term investments hereinafter), separately. Particularly, this chapter investigates whether the value of short-term investment is higher for certain firms, considering short-term investments may be optimal to hold for illiquidity premium.

In a frictionless market, the real value of cash holdings are exactly equal to their face value. Because firms can have access to costless external financing, holding cash has neither additional benefits nor costs, which makes cash holdings a net present value investments, firm value changes by the amount of changes in cash holdings (Duchin et al., 2017; Pinkowitz & Williamson, 2004). On the flip side, in the real world where frictions exist, cash holdings may be not equal to their face value, because there are benefits and costs of carrying cash. Consequently, the real value of cash holdings depends on whether they are positive net present value investments to shareholders. For example, precautionary motive of cash holdings should signal positive net present value of cash holdings, i.e. the value of one dollar should exceed one dollar. A secular increase in the value of cash holdings among U.S. firms since the 1990s is observed, especially among those newly listed innovative firms. These firms save extra cash holdings to mitigate underinvestment without seeking costly external financing. Hence the marginal value of one dollar increases above 1 to 1.12 for these firms (Bates, Chang, & Chi, 2018). Likewise, cash holdings are more valuable for financially constrained firms. Financial constraints impose restrictions on borrowing, precautionary cash holdings allow firms without external financing to capture growth opportunities (Denis & Sibilkov, 2009). Conversely, cash holdings are worth less because the costs of holdings cash exceed the benefits and cash holdings become negative net present value investments. In a firm with agent-shareholder conflicts, managers extract private benefits from cash holdings instead create value for shareholders, leading to a low value of cash holdings. Accordingly, a well governed firms without agency costs can have one additional dollar of cash holdings valued at 1.62, while the value of one dollar can down to 0.42 in a poorly governed firm with high agency costs (A. Dittmar & Mahrt-Smith, 2007). Therefore, the

[11] Definition of risk (Federal Reserve M4) differs from illiquidity (SFAS No.157), assets can be both risky and illiquid, see Duchin et al. (2017).

marginal value of total cash holdings fluctuates, and the direction of fluctuation lie on the balance of benefits and costs.

Looking into cash holdings closely, only the cash component can effectively react to the precautionary motive, but not the short-term investments component due to illiquidity. Liquidity of financial assets is positively related to short notices of liquidation (Myers & Rajan, 1998). Cash is discretionary and ready to be used, such high liquidity should represent the highest value among financial assets. However, short-term investments are relatively illiquid, the maturity of short-term investments can be as long as two years; to exploit these assets, firms can wait until maturity or liquidate ahead at a cost (Azar et al., 2016; Cardella et al., 2021; Duchin et al., 2017), this illiquidity should represent a lower value. Additionally, since the precautionary motive drives the increase in the recent trend of cash holdings (Bates et al., 2009), the top priority of cash holdings should be providing immediate liquidity to firm activities. Unconditional cash can serve the precautionary motive perfectly, while short-term investments cannot. Duchin et al. (2017) reckon risky financial assets are 12.9% to 21.5% lower in marginal value compared with safe assets, and Cardella et al. (2021) deem the value of cash holdings decreases as the proportion of short-term increases. Therefore, at the mean level, the value of cash should be higher than short-term investments. Similar to the precautionary needs of investments, default risks can also lower the value of short-term investments. When firms have debt-repayment due, it is reasonable for firms to hold cash to pay down debt, firms hold less short-term investments in response to liabilities (Cardella et al., 2021). The relative illiquidity of short-term investments is against the job of providing liquidity, which results in a lower value.

Corresponding to the high liquidity of cash, the return on cash is low, in contrast the illiquidity of short-term investments is offset by higher return (Cardella et al., 2021; Duchin et al., 2017; Myers & Rajan, 1998). With firms more actively participating in the market, earnings on short-term investments are increasing (Azar et al., 2016), and compared with an average firm, the profits from short-term investments are around 2.5 times higher (Cardella et al., 2021)[12]. Firms thus decide the holdings of cash and short-term investments by finding a balance point on the liquidity and yields spectrum. The precautionary motive that requires great liquidity spurs more cash, as firms with greater liquidity need to avoid holding non-cash financial assets (Cardella et al., 2021; Duchin et al., 2017), weak precautionary motive should encourage firms to hold more short-term investments, one benefit is that extra yields reduce the cost of carry. Hence, for firms with fewer liquidity needs, holding a large amount

[12] Average extra yields of short-term investments reach 4.5 million dollars or 4.5% of EBIT (Cardella et al., 2021).

of cash can be a burden, while high yields of short-term investments can lower the cost of carry, which should increase the value of short-term investments.

This chapter considers three occasions in which liquidity needs are low and intention of lowering the cost of carry is strong, namely when firms have fewer growth options, when firms are financially unconstrained and when firms are poorly governed. In the first two conditions, the precautionary motive is weak, firms either have no investments to spend cash holdings on, or they have alternative financing to fund investments, both making cash holdings less necessary. If firms hold more cash among the total cash holdings, it will increase holding costs due to low returns. Instead, if firms save more cash holdings as short-term investments, they not only secure future funding, but also earn extra yields that reduce holding costs. Therefore, the value of short-term investments should be greater.

In the last situation, short-term investments may be more valuable because short-term investments prevent redundant liquidity needs. Although under precautionary moves cash provides immediate liquidity, it also creates space for self-interested managers to extract private benefits through firm activities such as investments that are value-decreasing (Harford et al., 2008; Harford et al., 2017). Cash holdings are discounted because agency costs are produced when cash savings are not spent properly. Given the liquidation process and related risks of loss in value, managers may not easily convert short-term investments into cash, they should spend available cash more wisely and only tap short-term investments for highly profitable projects. Therefore, short-term investments are likely to be valued higher if they can reduce agency costs.

In brief, the value of cash and short-term investments is determined by the liquidity needs of firms, immediate demand for cash holdings raises the value of cash, while later use inflates the value of short-term investments. To test the idea, this chapter focuses on the U.S.-listed non-financial and non-utility firms in Compustat, the sample consists of 2,512 firms and 22,652 observations, covering three decades from years 1990 to 2019. By following the tactic from Pinkowitz et al. (2006), this chapter yields several findings.

First, on average, short-term investments are less valuable than cash. Despite both cash and short-term investments improving firm value by more than their par value, one dollar of cash increases firm value by 1.56, and short-term investments increase firm value by 1.03 per dollar. In other words, one dollar of cash is worth 1.56, and one dollar of short-term investments is worth 1.03, only slightly higher than face value, which suggests shareholders and the market view cash holdings positively, but also differently. Besides, the results show that one dollar of total cash holdings is worth 1.4, close to the value of 1.2 estimated by (Pinkowitz et al., 2006), the increase in value is consistent with the trend documented by

(Bates et al., 2018).

This study also considers the effects of debt on the value of cash and short-term investments. The firms are sorted into groups by whether they have long-term debt due in each of the next five years. The tests show that the value of cash is always higher than short-term investments regardless of debt status, and the value of cash and short-term investments is always higher among firms without debt. For instance, in the first year, firms with immediate debt payments have a dollar of cash worth below its face value, and no value assigned for short-term investments. In a firm without debt repayment due, a dollar of cash and short-term investments is valued at 2.4 and 1.9. Presumably, cash is more valuable than short-term investments because of two reasons. Shareholders would expect firms to use cash holdings to increase firm value through investments for firms without debt, and they expect firms to reduce default risks by retiring debt for firms with debt repayment due, yet only cash can satisfy these needs, short-term investments must be liquidated in advance. Also, shareholders consider cash and short-term investments in latter firms to be relatively worthless as these assets are going to increase debtholder wealth, not shareholder wealth. Additionally, the intra-firm value difference between cash and short-term investments is largest in the first year and decreases gradually across time. In cross-section, this value gap disappears in two years, that is, the disparity in value of cash and short-term investments between firms with and without debt disappears in the third year.

Next, this chapter investigates where short-term investments are likely to be more valuable than cash. First liquidity needs. In low liquidity needs firms, the value of short-term investments is more valuable, as the funding needs of investment for firms are low in the near future, which incurs opportunity costs for large cash holdings. Measured by the market-to-book ratio, low investment needs earn a higher value for short-term investments, accordant with the low liquidity needs conjecture. By putting cash balance into short-term investments, firms with limited growth options can earn extra yields while securing long-distance future liquidity needs.

Second, financial constraints. It is expected that the short-term investments to be valued more for unconstrained firms, in the view of unconstrained firms do not rely on internal liquidity, it is better off when cash is saved as short-term investments to earn yields. By adopting the SA index (Hadlock & Pierce, 2010) as the financial constraint criterion, cash is found to be more valuable for constrained firms and the opposite in unconstrained firms, in line with the observation that short-term investments are less in constrained firms (Cardella et al., 2021; Duchin et al., 2017).

Third, corporate governance. In poorly governed firms, short-term investments are more

valuable than cash. The ownership of insiders is used to proxy the quality of corporate governance by following previous studies (Denis & Sibilkov, 2009; Harford et al., 2008; Opler et al., 1999). Higher insider ownership may favour riskiness, which intensifies debtholder-shareholder conflicts, but aligns managers and shareholders, because in this way cash holdings are fully exploited to maximize shareholder wealth. Furthermore, managers avoid money wasting when they become shareholders. Therefore, the quality of corporate governance improves with insider ownership. Agreeing with the hypothesis, the model estimates a dollar of short-term investments is worth 18 cents more than a dollar of cash in low insider ownership firms. For well-governed firms, there is less concern regarding agency conflicts, and no significant difference between these two types of cash savings is witnessed. Additionally, the value of investments financed by cash and short-term investments respectively is quantified. If short-term investments in poorly governed firms are more valuable because they are associated with less money-wasting activities, then the value of investments backed by cash and short-term investments should differ. Following Kyröläinen, Tan, and Karjalainen (2013), the tests use the baseline model but with a different focus on independent variables. Precisely, the model concentrates on the variable that reflects the increased part of total assets and use it to represent investments. Compatible with the presumption, in a zero-insider company, negative coefficients of cash signal these investments are either value-decreasing, or inversely, short-term investments funded projects that are positively connected to firm value. Still, the relations between investments and firm value reverse when the corporate governance indicator is incorporated, as insider ownership ascends, the value of investments supported by short-term investments drops.

In all, the empirical results prove that short-term investments are not always lower in value, firms can benefit from holding more short-term investments when their investment choices are limited, or the governance structure is deficient. The results are robust by using the alternative approach introduced by M. Faulkender and Wang (2006).

This chapter contributes to existing literature in several ways. First, this chapter complements the studies that examine compositions of cash holdings. Cash and cash equivalent and short-term investments are rarely considered separately in a range of works. Azar et al. (2016) first document the long-term trend of positive changes in interest earnings of firm cash holdings and demonstrate the transition of cash holdings from being non-interest-bearing to interest-bearing. Further investigations from other works illustrate how cash and cash equivalent, short-term investments, and other financial assets evolve in cash management (Cardella et al., 2021; Duchin et al., 2017). This chapter extends the literature by evaluating the cash and cash equivalent and short-term investments separately. Second,

this chapter contributes to the literature valuing cash holdings in cross-section. Cardella et al. (2021) and Duchin et al. (2017) find the value of cash holdings with greater proportion of short-term investments or risky financial assets are less valuable, this chapter confirms the value of cash is higher than short-term investments at mean level. Importantly, this chapter identifies the environment where the value of short-term investments is greater than the value of cash. Firms are better off with holding more short-term investments than cash when near-term growth options are rare, corporate governance quality is low, and financial constraints are eased. Third, this chapter sheds light on corporate governance in a new perspective. Existing literature focuses on the relations between corporate governance and the value of cash holdings by contemplating external factors, including firm- or country-level governance, laws and regulations, monitoring and scrutiny (Aktas et al., 2019; A. Dittmar & Mahrt-Smith, 2007; A. Dittmar et al., 2003; Haw et al., 2011; Tong, 2011). The mainstream of the literature deems good corporate governance upvalues cash holdings, and this chapter finds consistent evidence that cash value increases with good governance. Noticeably, this chapter advises a higher value of short-term investments in poorly governed firms, and investments funded by short-term investments are more valuable than those backed by cash. This chapter thus contributes to current literature by suggesting cash balance *per se* can be a useful facility to eliminate agency costs.

This chapter arranges as follows: Section 2.3 summarizes the related literature and brings hypotheses; Section 2.4 explains data and empirical designs; Section 2.5 and 2.6 report empirical results; Section 2.7 reviews this chapter and concludes the findings.

2.3 Literature Review and Hypotheses Development

2.3.1 Compositions of Cash Holdings

Traditionally, cash holding is noticed when studies look at its determinants and effects, but little attention was attracted by cash holding itself.

Duchin et al. (2017) look beyond the traditional proxy of cash holdings and extend to all other financial assets that have not been aware of. By including cash and cash equivalent, short-term and long-term investments and other assets reported, the firm total financial assets are 24.6% larger than the common measure. Particularly, 23.2% of the conventional measure of cash holdings and 38.3% of total financial assets are risky assets, such as MBS, and 79% of the risky assets from the total financial assets are illiquid. A model is built to determine the optimal size and composition of firm cash holdings. In the model, firms solve the

problems of allocating initial capital on real investments (both current and future investments) and financial assets with different liquidity and risk levels. The model indicates that when firms can forecast their cash demand, a constrained firm with insufficient initial capital requires returns from prior investments to fund future investments, while an unconstrained firms have sufficient initial capital to fund future investments without considering prior investments. Constrained firms thus do not invest in illiquid assets that cannot be used to finance future investments unless they are liquidated as a loss, unconstrained firms are indifferent to investment in illiquid assets. Hence, without sufficient liquidity, constrained firms should maintain its assets liquid for future cash needs, investing in illiquid assets is suboptimal for them due to the liquidation costs, unconstrained firms have sufficient liquidity for their needs, they should find illiquidity premium makes investing in illiquidt assets optimal. Unconstrained firms with weak precautionary motives like low cash flow volatility, large firm size, and fewer growth opportunities, also hold more risky assets, whereas constrained firms shun these assets. Along with increases in the size of total financial assets, the volume and diversity of risky assets increase. Poor corporate governance and managerial overconfidence and risk-taking lead to more risky assets, where the former facilitates extracting private benefits from risky assets, whereas the latter expects extra income from risky assets. However, firms use cash saved from internal cash flows to finance risky assets, the cash being less valuable to shareholders. Conversely, safe assets financed by externally sourced cash are valued more highly. Additionally, holdings of risky assets are indifferent to corporate taxes.

Cardella et al. (2021) examine the composition of cash holdings measured by the sum of cash and cash equivalent and short-term investments. Cash and cash equivalents are pure cash and liquid short-term investments with remaining maturity below 90 days, these assets are at discretionary use but earn low returns. Short-term investments are financial assets with maturity over 90 days, typically between 1 and 2 years; from 1980 holdings of these assets become prevalent and accounted for 26% of total cash holdings on average. Short-term investments earn higher returns but are less liquid and firms do not usually liquidate them until maturity due to interest rate risk and transaction costs. The value of cash holdings with a larger fraction of short-term investments is lower. Accordingly, empirical evidence reveals that firms with greater demand for immediate liquidity are less likely to hold short-term investments and hold less if they had such assets, such as financially constrained firms, firms with less total cash balance, smaller firms, firms experiencing a shortage of credit supply, firms with uncertainty about short-term liquidity needs, firms with high default risks on debt, firms with larger spending on investments, operations, and payouts, or firms using more

trade credit that triggers high financial risks. Access to credit lines also makes firms hold fewer short-term investments, as firms hold less total cash to maintain daily needs, which require highly liquid cash. Since systematic risks limit access to credit lines, firms with greater systematic risks hold more total cash and more short-term investments. Likewise, some firms substitute cash with inventories, they hold more inventories and less total cash; remaining cash holdings are liquid in order to fund daily needs by investing in less short-term investments.

Cash holdings do not just consist of one single element, namely simple cash in non-interest-bearing accounts, but also other complicated financial assets. Evidence suggests this trend of firms saving cash holdings as non-cash financial assets may have sustained for some time. Azar et al. (2016) analyse the effects of the cost of cash holdings on variations in cash levels. The cost of carry is measured by the difference between the U.S. treasury bill rate and return on liquid-assets portfolios, where liquid assets are held in non-interest-bearing accounts that earn nominal treasury bill rate, as U.S. firms were not allowed to hold cash in interest-bearing accounts until the 1980s, after which firms increased holdings in interest-bearing accounts, thus the difference (cost-of-carry) decreases. Empirically, the lower cost of carry induces firms to hold more cash after the 1980s, opposite to cash reduction before 1980 as the cost was higher. Difference-in-difference tests indicate firms with more cash in non-interest-bearing accounts hoard more cash after 1980, when the cost is lower, because these firms are more likely to face higher demand over near future liquidity, firms with distant-future use of cash prefer saving cash in interest-bearing accounts respond less actively to lower cost of carry. A similar trend is found in other advanced economies. Moreover, cash flow volatility does not seem to explain the variation in cash holdings, as cash flow volatility is negatively related to cash holdings, and cash flow volatility increased monotonically after 1945, while the curve of cash holdings is reversed V-shaped.

Other studies find the preference for holding non-cash financial assets may vary over time. Kamstra, Kramer, Levi, and Wermers (2017) links seasonality to flows of capital among assets with different levels of risk in mutual funds. Specifically, individuals in the U.S., Canada and Australia shift cash from risky assets to safe assets during autumn and winter, but they shift from safe assets to risky assets during spring and summer. The intuition is that investor sentiment is affected by seasonal factors: investors are risk averse in autumn and winter, yet become risk preferred in spring and summer.

2.3.2 External Financing and Value of Cash Holdings

Firms hold cash against cash shortfalls, especially cash shortfalls caused by exogenous shocks, external financing thus becomes an important determinant of cash holdings and an important determinant of cash value.

Gamba and Triantis (2008) study the value of financial flexibility. Their model suggests net firm value is a concave function of cash level. The value of cash, which is a source of financial flexibility, comes from the savings of external financing costs, higher distress costs and equity flotation costs. When firms have less cash, the benefits of holding cash from these cost savings are larger than tax disadvantages. With an increase in cash holdings, the marginal increase in benefits shrinks and eventually tax disadvantages exceed benefits when cash is above optimal level and so net firm value declines. Moreover, the net firm value increases with an equal increase in both cash and debt, namely the net debt remains at zero, until the marginal increase of net firm value gradually becomes zero.

M. Faulkender and Wang (2006) quantify the value of firm cash holdings and the cross-sectional variation in cash value. At the mean level, one dollar of cash is worth 0.94, which is slightly lower than its par value. Three cash regimes decide the variation in cash value. The value of cash decreases further if firms have larger cash reserves. In raising the cash regime, cash is more valuable, since cash holdings avoid external financing costs in cash-poor firms, whereas in a distributing cash regime, cash-rich firms are more likely to incur higher tax and agency costs on cash holding interests, which decreases cash value. Consequently, cash becomes more valuable in financially constrained firms, which are restricted to external financing, and less valuable in financially unconstrained firms. This impact is pronounced in constrained firms with more growth opportunities, as these firms are more likely to seek external financing and induce high costs. Cash is worth 0.13 more if it is distributed as share repurchases rather than cash dividends, and as the latter is taxed at a higher level, shareholders eventually receive less. Besides, in the cash regime of serving debt and liabilities, cash value decreases because paydown by cash holdings increases debt value, not equity value, shareholders thus perceive lower value of cash.

Meanwhile, as more subsequent research evaluates cash holdings based on the method developed by M. Faulkender and Wang (2006), Halford, McConnell, Sibilkov, and Zaiats (2021) challenge the reliability of the method. By considering different cash regimes, i.e. raising cash regime, insufficient cash but not raising cash regime, and excess cash regime, their model estimates the benchmark value of a dollar is worth up to 1.09. The traditional measure of cash value by M. Faulkender and Wang (2006) indicates that the marginal value of cash holdings stems from the savings of transaction costs. However, in some studies, a dollar is worth far more than its par value in well-governed firms, which produces

contradictory verdicts that these firms with greater access to external financing face higher financing costs. Particularly, this traditional measure generates different values for cash during the time firms accumulate and disgorge cash, but theoretically the value should be the same. And the bias does not improve after controlling changes in cash holdings and omitted variables. Nevertheless, the estimates from this method can still provide important information subject to specific conditions. For instance, it is reasonable that good corporate governance improves cash value when both initial and improved value is below 1, but implausible if they are above 1. Because in the latter case, the excess value above 1 is associated with external financing costs, which should be eliminated by good governance.

Denis and Sibilkov (2009) reveal the impacts of financial constraints on the value and size of cash holdings. Financial constraints limit access to external financing and encourage firms to build cash reserves as a replacement for external financing, so financially constrained firms without external financing can fund investments. Therefore, cash becomes more valuable since it helps firms to undertake investments that increase firm value. This effect is stronger for constrained firms with greater hedging needs. However, constrained firms do not necessarily have high cash holdings despite the value of cash and the propensity for holding cash being high. Because constrained firms are likely to have both limited internal and external financing, especially persistent negative free cash flows, insufficient resources are hard to support a high cash balance whilst meeting other needs, such as investments.

Décamps, Mariotti, Rochet, and Villeneuve (2011) solve the optimal cash policies through a model in which firms face agency costs and external financing costs. The model predicts that when these two frictions are in place, firms should accumulate cash until it reaches the target level (or dividend boundary) and distributes excess cash to shareholders. The value of cash is a concave function of the size of cash holdings, it is greater than one when cash is above zero and below the target level and equal to one when cash is at or above the target level. Cash value in cash-poor firms is negatively related to the volatility of cash flows and positively related to the volatility in cash-rich firms. The target level increases with equity issuance costs, meanwhile, the firm value decreases with issuance costs and firms must hold more cash, and cash value thus increases with issuance costs. When issuance cost is low, the target level increases with the volatility of cash flows but decreases with firm profitability; and when issuance cost is high, the target level is a convex function of profitability. The target also decreases monotonically with agency costs.

Favara, Gao, and Giannetti (2021) consider the effects of access to external financing on firm policies and performance. By deploying anti-recharacterization laws, the U.S. debt market protects creditors from bad debt by granting them more power to repossess borrower

assets. Accordingly, firms have greater access to debt financing as collateral value increases. Difference-in-difference tests show that in response to higher uncertainty, which is measured by industry cash flow volatility, firms with more access to debt reduce cash holdings, increase payouts, leverage and intangibility, and firms also become more profitable, use fewer derivatives to hedge against uncertainty. Also, eased access to debt financing strengthens the firm ability to resist extra exogenous, as firms do not reintroduce precautionary behaviour when geopolitical risks increase.

2.3.3 Corporate Investments and Value of Cash Holdings

Although cash value is strongly related to external financing, cash holdings are expected to fund corporate activities, particularly investments, which in turn affect the value of cash holdings. And eventually, the value of cash holdings is dependent on whether the cash holdings-financed investments are firm value-enhancing.

Pinkowitz and Williamson (2004) estimate the exact value of firm cash holdings and cross-sectional differences in cash value. On average, they show the worth of one dollar is between 1.19 and 1.25. The benefit of cash holdings is that firms have better growth opportunities because additional cash allows firms to undertake valuable investment projects. The volatility of growth opportunities can also increase cash value, as sufficient cash holdings mitigate the uncertainty of growth options and enable firms to undertake positive NPV projects when they arrive unexpectedly; conversely, cash is less necessary when firms with known investments can plan their financing well ahead. Moreover, financial distress decreases cash value, additional cash only benefits creditors rather than shareholders, who would prefer risky projects other than safe assets such as cash. However, there is no support for access to external financing affects cash value.

Bates et al. (2018) document a secular increase in the value of cash holdings in the last thirty years, with a dollar worth 0.61 in the 1980s growing to 1.12 in the 2000s. And in each of the three decades, the value of cash holdings is greater for smaller firms, firms with more growth opportunities, financially constrained firms, and firms with high cash flow volatility. Further analysis indicates factors that drive such increases are different in different periods. Newly listed firms contribute to increases in both the 1990s and 2000s but more in the 1990s. By controlling firms being newly listed, the value of cash holdings also increases with growth opportunities and cash flow volatility in the 1990s; increases occur with financial constraints in all years but are more pronounced in the later period, and increases with credit spreads that measure credit supply condition in the 2000s. Besides, the increase in the value of cash

can be attributed to increased market competition, decreased firm business diversification and positive investor sentiment. Contingent on the measure of corporate governance, improved governance also explains the inflated value of cash in time series and cross-sections. However, despite the growth in the value of cash, firms with cash deficits (below target cash level) adjust their cash holdings towards target slowly due to market frictions, especially for financially constrained firms.

Alimov (2014) build a causal link between market competition and the value of cash holdings using difference-in-difference tests based on the passage of FTA, which reduces trade limits between the U.S. and Canada and intensifies the competition in the U.S. market. Empirical results suggest cash value inflates 0.59 per dollar with increased competition, as more cash enables firms to compete with an increased number of rivals by undertaking investments and keeping the market share. However, although the FTA also gives U.S. companies more growth opportunities for entering the Canadian market freely, the value of cash does not change because of this reason.

W. Huang and Mazouz (2018) show that although there is a potential free cash problem associated with excess cash, it appears that external traders treat the benefits of excess cash to avoid cash shortfalls outweigh the cost of carry. An increased number of traders implies more trading, which diminishes trading discontinuity and liquidity risks (liquidity beta), thus excess cash holdings ameliorate stock liquidity. Reduction in trading discontinuity subsequently lowers the liquidity premium and the cost of capital, especially for financially constrained or growth firms. In addition, excess cash holdings increase firm value for illiquid firms.

Aktas et al. (2019) indicate the value of cash holdings by addressing human factors. In the context that the firm is managed by an overconfident CEO, who is against external financing and reliant on internal financing, the value of cash holdings is higher than its par value. This effect is stronger among firms that have insufficient internal liquidity, such as firms that are in a cash-raising regime and financially constrained, and firms with more growth opportunities, because less internal financing limits the overconfident CEO to undertake valuable projects, additional cash relaxes the financial restraint and mitigates underinvestment. In contrast, for firms with sufficient cash holdings, such as unconstrained firms, additional cash is worth less as it facilitates overinvestment.

Kisser (2013) tracks the pattern of cash value with growth opportunities under the trade-off between external financing costs and agency costs. Benchmarking against equity-financed investments, cash-financed investments have a higher investment threshold (firms delay investments) if the cash level is low relative to investment costs, as firms can invest in the

future at lower costs unless firms already hold sufficient cash that allows firms to invest earlier (lower threshold). And this investment threshold increases with investment costs; firms optimally save cash and invest later when investment costs are low but save less and invest earlier when the costs become higher. Therefore, cash is valuable when there are more investment opportunities, especially when cash is low. It reduces external financing costs but its value decreases with external financing costs, and it is never optimal to execute full retention of cash flows. Likewise, investment threshold increases with cash flow volatility, low cash flow volatility decreases investment and cash value is negatively related to cash flow volatility, because uncertainty from high cash flow volatility curtails efficient plans over finance and investments, unless bankruptcy risk is high. Empirically, one dollar is valued at 0.72 for all-equity financed firms. The cash value increases with growth opportunities, but the positive relation becomes negative when cash flow volatility increases. Cash holdings are negatively related to investments when cash is at a low level but are positively related to investments when cash is at a high level.

Hence, the value of cash holdings is not always above its par value, especially when investments can be non-profitable, many of them bring negative effects on firm performance, which spill over to the value of cash.

For example, Harford (1999) deliberates on the effects of cash holdings on acquisitions. They find firms are more likely to initiate acquisition deals, especially diversified targets and targets that are not promising to their peers if firms hold excess cash. These acquisition deals are found to be value-decreasing as revealed by the negative relations between abnormal returns and bid announcements. Following successful deals, the return on assets of merged firms declines sharply. Consequently, shareholders expect high cash to incur agency costs unless it is to be paid out, and every dollar decreases the firm value by seven cents.

Y. Liu and Mauer (2011) measure the effects of risk-taking incentives on cash holdings and the value of cash holdings. Empirical proofs reveal that the risk-taking incentives (*Vega*: the sensitivity of CEO compensation to stock return volatility; *Delta*: the sensitivity of CEO firm wealth to stock price changes) increase cash holdings. Furthermore, risk-taking incentives reduce cash value, especially for highly levered firms. The two findings together suggest that firms hold more cash because creditors protect themselves by introducing liquidity covenants in response to risk-taking behaviour, the covenants-incurred high cash levels subsequently become less valuable to shareholders. However, risk-taking incentives are insignificantly but positively related to cash value for financially constrained firms, which illustrates that firms may also save cash to avoid costly external financing.

2.3.4 Corporate Governance and Value of Cash Holdings

Existing studies imply firm policies of financing and investments both affect the value of cash holdings significantly. The direction in which firm policies alter cash value is ultimately contingent on the use of cash holdings, wasteful spending makes cash worth less. Conversely, fair consumption makes cash more valuable. Consequently, corporate governance that intervenes in the use of cash holdings also indirectly impacts cash value.

A. Dittmar and Mahrt-Smith (2007) gauge the effects of corporate governance on the value of firm cash holdings. Measured by managerial entrenchments and institutional shareholder levels, good corporate governance increases the value of total cash holdings by around 50% and increases the value of excess cash holdings by 30% to 40%. This is because corporate governance affects the use of cash holdings. Poorly governed firms spend excess cash quickly, which subsequently exerts negative influences on operating performance. Poor governance hence destroys cash value by allowing wasteful spending. However, corporate governance does not affect the accumulation of cash holdings.

Tong (2011) investigates the impacts of firm diversification on the value of cash holdings. Although diversification provides firms with an opportunity to allocate cash efficiently through the internal capital market, empirically the value of cash is found to be lower for diversified firms, regardless of financial constraints, which suggests that diversification exacerbates agency conflicts and decreases cash value. Further evidence confirms the findings by showing that good corporate governance alleviates the negative effects of diversification on the value of cash holdings.

Phan, Simpson, and Nguyen (2017) probe the linkages between promotion-based incentives and firm cash holdings, and the value of firm cash holdings. Promotion-based incentives motivate the risk-taking of non-CEO executives to outperform competitors to become the next CEO. Empirical estimation finds that promotion-based incentives increase both firm cash holdings and the value of cash holdings, especially for financially constrained firms. This is because risk-taking intensifies firm cash flow volatility, firms hold more cash to avoid liquidity shortfalls, hence cash value increases as it mitigates underinvestment. However, the effects of promotion-based incentives on cash and cash value only work in times when promotions are more likely to happen, e.g. expected retirement of incumbents.

Ward, Yin, and Zeng (2018) believe institutional investors only provide effective monitoring of firms when the monitored target is important in their investment portfolios. Specifically, by examining firms that account for at least 10% of the value of institutional investor portfolios, they find institutional investor ownership is positively related to the value of cash

holdings. Because these firms represent relatively more importance in portfolios, institutional investors would like to assign more attention to monitoring these firms. The more important these firms are to institutional investors, the more monitoring these firms receive, and cash value increases.

Florackis and Sainani (2018) evaluate the role of CFOs on firm cash holdings of UK firms, in which CFOs undertake more important tasks than in U.S. firms. By constructing an index that measures the ability of CFOs to influence corporate financial policies, the authors find strong CEOs, who have more power over firm outcomes hold less cash. This effect holds in both firms that CFOs have full or partial control of financial policies. Subtests reveal that the results are driven by precautionary motives. Financially unconstrained firms with less precautionary incentives decrease cash holdings with CFOs becoming stronger, but constrained firms do not. Strong CFOs also have greater access to debt, especially in downturns, which further weakens precautionary motives. Particularly, the value of cash is higher among unconstrained firms with strong CFOs, not constrained firms, which suggests the difference in precautionary needs. Moreover, strong CFOs hold even less cash in firms with higher agency costs, it is likely these CFOs provide monitoring beyond their main job.

H. Chen et al. (2020) investigate how internal controls aim to reduce firm risks that involve operations, compliance, finance, and assets affect cash holdings. By constructing internal control index and differentiating from corporate governance, they find with better internal controls, firms are more likely to stick to optimal cash levels and less likely to fall below or exceed the target. Internal controls encourage dividend increases and discourage acquisitions, especially after failure in preceding acquisitions. Also, internal controls improve the value of cash holdings.

Chowdhury, Doukas, and Park (2021) study how stakeholder orientation affects cash value. The passage of state-level constituency statutes increases stakeholder orientation by enabling firm decision-making to include more non-shareholder stakeholders and cover their interests. Difference-in-difference tests based on this event as an experiment indicate that firms with a greater degree of stakeholder orientation improve their cash value by 46.1%, especially for firms with previously weaker stakeholder orientation, greater agency conflicts, and larger information asymmetry. And firms experience heightened stakeholder orientation and subsequently reduce cash holdings to restrain agency costs. Stock-financed M&A transactions are vague since these deals are more likely to be made based on private information, increased stakeholder orientation helps to increase bidder returns amid these investments by reducing such information asymmetry. Additionally, increased stakeholder orientation mitigates both overinvestment and underinvestment of capital expenditures.

Apart from firm-level governance, country-level governance also works well in improving the value of cash holdings.

A. Dittmar et al. (2003) look into the effects of corporate governance on cash holdings in an international setting. Empirically, firms in countries with weak shareholder protection hold more cash than firms with good shareholder protection, and this relation is stronger after controlling capital market development and firm characteristics. This is because poor shareholder protection facilitates managers to extract private benefits from discretionary cash, which encourages the holding of higher cash balances. As external financing costs can be high along with weak shareholder protection, growth opportunities and dependence on external financing should drive firms to hold cash in response to the costs, yet additional tests suggest both growth opportunities and dependence on external financing have little effect on cash holdings of firms in countries with weak shareholder protection.

Frésard and Salva (2010) quantify the effects of U.S. cross-listing on reducing agency costs by estimating the value of excess cash holdings. Precisely, cash holdings in foreign firms listed in the U.S. market are more valuable than foreign firms that do not cross-list in the U.S., as a dollar is worth 1.61 if the firms cross-list in an exchange and are worth 1.42 if in the OTC market. This is because U.S. listing improves the legal and monitoring environment of listed firms, which constrains agency problems. Additional analysis reveals that cash value significantly increases once foreign firms are listed in the U.S. market, and the positive cash value is persistent, especially for firms located in countries with weak shareholder protection, the increase in value is larger. However, the value of excess cash is indifferent to the environment of the parent country of firms once they enter the U.S. capital market because shareholders consider the risks firms face to become more similar. Also, an increased number of financial analysts, large shareholders (with over 5% shares) and institutional shareholders for firms further increase the value of excess cash, these related entities provide monitoring that helps to reduce agency costs. Finally, private placements that do not impose such restrictions have no significant effects on the value of excess cash. For example, UK cross-listing does not change the legal environment, it only provides monitoring, so listing in the UK market has moderate influences on enhancing the value of excess cash.

Haw et al. (2011) demonstrate the impacts of different means of payouts on firm value and cash value across countries. Share repurchases and dividends differ in influences on agency costs. Share repurchases are discretionary and common in disgorging cash windfalls. By signalling false information to investors, share repurchases can lower the cost of financing and facilitate insiders to extract private interests by exercising option holdings, yet investor

protection can mitigate such imperfections. Payouts through dividends are regular and consistent, negative changes in dividends may incur backlash from investors, which can lower agency costs. Hence, empirical evidence shows that share repurchases increase the firm value more for the firms in countries with strong investor protection than in countries with weak investor protection. In weak investor protection countries, firm value is 60% higher if the firm pays out dividends. Similarly, share repurchases make cash more valuable than dividends for firms with strong investor protection, whereas dividends increase more cash value for firms with weak investor protection.

Kyröläinen et al. (2013) focus on the relationship between cash value and creditor rights. Legal protection for creditors is negatively related to firm financial constraints because creditors are more likely to approve lending when they can protect themselves from firm default, in which firms are unable to repay the debt. Therefore, weak creditor protection intensifies financial constraints, and empirically, the value of cash holdings is found to be higher in countries with poor creditor rights, for both cash-poor and cash-rich firms. The value of cash is higher in firms with cash below optimal level because additional cash holdings avoid costly external financing and mitigate underinvestment, whereas, in firms with excess cash, cash is more valuable because financial constraints discipline discretionary use of cash to be less wasteful. Additionally, as strong creditor protection reduces cash value, it only holds for countries with good country-level governance (which is proxied by six dimensions in politics, regulation, and government quality).

2.3.5 Alternative Value of Cash Holdings

Cash holdings as a part of firm assets, can be exploited directly to fund daily business. In addition to this direct exploitation, the value of cash holdings may be reflected by the opportunity cash holdings provide to acquire external financing.

Myers and Rajan (1998) argue against the view that great asset liquidity means greater access to external financing. Although liquid assets are more valuable in short-notice liquidation, their model indicates that liquid assets cannot facilitate borrowing unless these assets are frozen from liquidation and assigned as collateral, which conflicts with the intention of firms to maintain the flexibility of liquidation. It occurs because creditors would like to protect themselves, despite the higher liquidation value of liquid assets, asset illiquidity increases the chance that creditors can repossess the assets if a firm defaults. Therefore, firms can choose to invest in illiquid projects with external financing, or they can raise less external financing at the expense of creditors by limiting their control over firm assets.

Parlatore (2019) explains the motive behind collateralizing financial assets rather than liquidating the assets to raise external financing. Under the premise that firms invest in risky projects with uncertainty over returns, it makes no difference for firms to sell or collateralize financial assets if these assets are perfectly liquid because it does not cost borrowers more to sell than to collateralize. When financial assets are not perfectly liquid, borrowers are restricted to the asset market, and they overvalue the financial assets they have, which leads to the preference for collateralizing. However, the value of financial assets is discounted due to their illiquidity, whereas assigned as collateral, financial assets can obtain a premium.

2.3.6 Hypotheses Construction

The distinction between cash and short-term investments is the degree of liquidity. This difference in liquidity brings two effects on cash management. First, efficiency. Cash is the most liquid and unconditional financial asset, it can be allocated directly to firm activities, while short-term investments must be liquidated into cash before these assets can be considered as financing resources (Azar et al., 2016). Second, liquidation risks. Illiquidity is negatively related to the liquidation value of short-term investments on short notice (Myers & Rajan, 1998). Particularly interest rate risk, which exposes short-term investments to the chance of loss in value when liquidating (Cardella et al., 2021). Hence, firms typically intend to hold short-term investments until maturity. Short-term investments thus are only usable after their maturity, or after being liquidated in advance with the risk of receiving lower liquidation value; both disqualify short-term investments as effective financing methods.

However, according to the precautionary motive, whenever there are funding needs cash holdings should be at the firms' discretion, especially as cash holdings increase financial flexibility, which helps against credit supply shortage (Rapp, Schmid, & Urban, 2014), and clearly illiquidity of short-term investments decides that short-term investments are inflexible and incapable of providing discretionary financing. Failing precautionary needs means short-term investments are less competitive as liquidity tools, firms subsequently may be unable to undertake valuable investment projects or meet their liabilities, which leads to lower firm value. In contrast, the more liquid assets firms have, or the higher likelihood of investing in more liquid assets, the more liquid firm stocks are (Gopalan et al., 2012), which reflects higher firm value (Cheung, Chung, & Fung, 2015; Fang, Noe, & Tice, 2009; Massa & Xu, 2013). Therefore, cash holdings saved as short-term should be less valuable from the view of the market.

Hypothesis 1 The cash holdings saved as short-term investments are valued lower by shareholders and the market than cash.

The value of short-term investments may also be lower when firms have debt repayment due. First, the cash holdings in firms with more borrowing are generally worth less than those in firms without borrowing. There are two channels leading to a lower value of cash holdings: primarily, debt covenants. Unlike equity, it is common that debtholders do not have the right to monitor and intervene in operations of obligated companies, except bank credit lines. Creditors consequently would require deposits or collateral to secure future repayment against default risks (Y. Liu & Mauer, 2011; Phan et al., 2017). With such covenants, firms must pay the opportunity costs related to the part of cash holdings that is unable to create firm value. Next, debt repayments. With debt repayments due shortly, firms again must use fewer cash holdings to avoid default. As the cash holdings will be distributed to creditors instead of increasing firm value, the value of cash holdings is discounted in highly levered firms (M. Faulkender & Wang, 2006).

Second, in the case that firms with upcoming debt repayment requirements, short-term investments are less valuable than cash. Because short-term investments are less liquid, they cannot be used to pay down debt unless liquidated first. Cardella et al. (2021) find that the amount of cash increases whilst the level of short-term investments decreases when firms are required to pay down debt soon. Therefore, the prerequisite liquidation process adds extra costs to short-term investments as shareholders would consider short-term investments to be less valuable than cash with more near-term debt repayments.

Hypothesis 2 The cash holdings saved as short-term investments are valued lower by shareholders and the market than cash when firms have debt repayments due.

In contrast to cash which is liquid but earns lower returns, short-term investments are less liquid, but the illiquidity is compensated by higher yields (Cardella et al., 2021). Firms decide the proportion of cash and short-term investments by balancing liquidity needs and higher yields. Cash holdings are valuable because they improve firm performance by providing direct financing (Almeida et al., 2012; Malamud & Zucchi, 2019). Short-term investments are less valuable because they are not directly available as funding. This occurs when firm liquidity needs dominate the benefits of higher yields. If the higher yields of short-term investments become more attractive, in other words, liquidity needs are small, short-term investments should be more valuable. Hence, when there are limited growth

opportunities, shareholders should favour short-term investments over cash.

Precisely, short-term investments should hold a higher value than cash when the precautionary motive is weak, firms hold short-term investments for distant future needs and take advantage of its liquidity premium. Cardella et al. (2021) find firms not only intend to hold short-term investments until maturity and following growth in investments, but firms also hold a higher volume of short-term investments when they have lower short-term liquidity needs. Beyond the traditional measure of cash holdings, Duchin et al. (2017) discover that financial assets with long maturity positively respond to proxies of precautionary motives too. Taken together, when firms expect no immediate needs, they save cash holdings as short-term investments to secure future liquidity while its illiquidity is rewarded with high yields.

Hypothesis 3 The cash holdings saved as short-term investments are valued higher by shareholders and the market than cash when firms face lower short-term liquidity needs.

This chapter also proposes two other situations in which firms may not have forthcoming liquidity needs and the value of short-term investments become higher. First, when there is greater access to external financing. Financial constraint is one of the important determinants of cash holdings. Financially constrained firms do not have access to external financing and must rely on internal liquidity. These firms have a greater propensity for saving cash out of cash flows, this propensity persists even when financially constrained firms have access to external financing, such as credit lines, as they wish to mitigate refinancing risks (Almeida et al., 2004; Chang et al., 2014; Harford et al., 2014). The value of cash holdings is greater for these firms since additional cash enables constrained firms to undertake investments (Denis & Sibilkov, 2009). Therefore, short-term investments should be less valuable than cash given short-term investments cannot satisfy the liquidity needs of financially constrained firms despite higher yields.

Nevertheless, financially unconstrained firms have greater access to external financing, internal liquidity is less important to fundings of daily operations, and they only save a small proportion of cash holdings for general purposes (Lins et al., 2010), otherwise, unconstrained firms can also save large cash holdings for longer future needs (Cunha & Pollet, 2019). It is less necessary for financially unconstrained firms to maintain highly liquid cash holdings, and cash holdings are worth less among unconstrained firms than constrained firms. Instead, financially unconstrained firms can lower the cost of carry by converting the redundant cash into short-term investments to exploit the higher yield of short-term investments. Therefore,

the value of short-term investments should be higher than cash for financially unconstrained firms.

Hypothesis 4 The cash holdings saved as short-term investments are valued higher by shareholders and the market than cash when firms are financially unconstrained.

Second, when there are agency conflicts. The benefits of short-term investments may include indirectly lowering agency costs, which makes the value of short-term investments weigh over cash. Cash is discretionary, it helps managers to avoid costly external financing and undertake unexpected profitable projects. However, cash also facilitates managers to extract private benefits by making value-decreasing investments. In lack of monitoring, self-interested managers build larger cash reserves than other firms but deplete cash holdings quickly on expansion instead of payouts, which results in overinvestment and a decrease in firm value (Harford et al., 2008), especially for multinational firms that hold more cash overseas, it may further cause insufficient liquidity in the parent companies and underinvestment (Harford et al., 2017). Although CEO overconfidence is not regarded as an agency problem, it certainly shows some similarities, such as holding a transitory high cash balance and high investment level (Y.-R. Chen, Ho, & Yeh, 2020; Deshmukh et al., 2021). Accordingly, the unwanted ineffective using of cash holdings decreases shareholder wealth, shareholders thus consider the value of cash holdings to be lower (Aktas et al., 2019; A. Dittmar & Mahrt-Smith, 2007).
In contrast, employing short-term investments as a funding source must after they are liquidated, which can incur high liquidation costs. Firms may be discouraged to make profitable investments, but it is also likely to add barriers to managers who would like to extract private benefits from cash holdings. Unlike self-interested agents, overconfident CEOs may consider these financial assets to be alternative investments rather than part of cash holdings (Duchin et al., 2017). The likelihood of overconfident CEOs spending these resources on value-decreasing projects decreases. Therefore, if short-term investments reduce the money-wasting behaviour of managers, the value of short-term investments should be higher than cash.

Hypothesis 5 The cash holdings saved as short-term investments are valued higher by shareholders and the market than cash when firms face higher agency costs.

2.4 Empirical Strategy

2.4.1 Data and Samples

This chapter focuses on U.S. publicly traded firms only, including those on the OTC market, to reduce the effect of differences in laws and regulations imposed on companies, as previous studies have revealed the impact of legal factors on cash value. The data comes from multiple sources. For all company financial statements, the information is obtained from the CRSP/Compustat merged database, while Bloomberg provides details on insider ownership[13]. The sample period covers three decades from 1990 to 2019, however, the ownership information only starts from 2010. Following previous studies, financial firms with SIC codes lying between 6000 and 6999 and utility firms whose SIC codes belong to the interval from 4900 to 4949 are all removed, since their cash balances are likely to be subject to special arrangements. All the sample firms are required to be active during the sample period.

2.4.2 Measures of Cash and Short-term Investments

This chapter investigates the value of the composition of cash holdings, namely cash and cash equivalent and short-term investments. The two main variables are *Cash*, i.e. cash and cash equivalent, measured by Compustat item *ch*, and *FinancialAssets*, i.e. short-term investments, measured by *ivst*. The sum of *Cash* and *FinancialAssets* represents *TotalCash*, the conventional proxy of cash holdings *che*. Defined by FASB Statement No.95, assets that are reported as cash equivalents must meet two conditions: *a. Readily convertible to known amounts of cash; b. So near their maturity that they present insignificant risk of changes in value because of changes in interest rates*. Therefore, cash equivalents mainly differ from short-term investments in their maturity from the view of accounting, financial assets are cash equivalents if their maturity is equal to or less than three months at the time of purchase, and the rest goes to the short-term investments group. Importantly, the classification of cash equivalents and short-term investments is consistent across time. Specifically, the maturity for reporting purposes is counted from the time of purchase, financial assets with maturities longer than three months at the time of purchase are short-term investments. These assets will not be reclassified as cash equivalents if their maturities fall below three months during the period of holding[14]. Compustat therefore considers *ch* as any liquidity immediately

[13] The information of insider ownership from Bloomberg is sourced from SEC filling forms 3, 4 and 5. Insiders include officers, directors and individuals hold more than 10% of company securities. See SEC for more details.

[14] See FASB statement No.95 footnote 2.

available to firms and *ivst* as currently marketable investments. As Compustat describes the items they collect from fillings to fulfil *ch* and *ivst*, the composition of *ivst* is not publicly available[15]. To form a general idea of these assets, Cardella et al. (2021) hand-collect detailed holdings of short-term investments from 10-K fillings of 536 firms, which covers 1,200 firm years from 1997 to 2015. These assets include U.S. corporate debt, U.S. government debt, municipal debt, auction rate securities, certificates of deposit, equities, mutual funds, asset-backed securities, foreign debt, and other unclassified assets, where U.S. corporate debt and U.S. government debt together account for 63.62% of short-term investments and 33.9% of total cash holdings.

2.4.3 Model Specifications and Control Variables

There are two approaches available from extant studies to estimate the marginal value of cash holdings. The first is derived from Fama and French (1998) and the first to be modified and used by Pinkowitz et al. (2006). The model after adaption is presented below:

$$V_{i,t}=\alpha+\beta_1 E_{i,t}+\beta_2 dE_{i,t}+\beta_3 dE_{i,t+1}+\beta_4 dNA_{i,t}+\beta_5 dNA_{i,t+1}+\beta_6 RD_{i,t} +\beta_7 dRD_{i,t}+\beta_8 dRD_{i,t+1}+\beta_9 I_{i,t}+\beta_{10} dI_{i,t}+\beta_{11} dI_{i,t+1}+\beta_{12} D_{i,t} +\beta_{13} dD_{i,t}+\beta_{14} dD_{i,t+1}+\beta_{15} dV_{i,t+1}+\beta_{16} dL_{i,t}+\beta_{17} dL_{i,t+1}+\varepsilon_{i,t} \quad (2\text{-}1)$$

Where $X_{i,t}$ is the value of the variable in year t, $dX_{i,t}$ and $dX_{i,t+1}$ are the lagged and lead value changes of the variable $X_{i,t}$ in year t, i.e., $X_{i,t}$ - $X_{i,t-1}$ and $X_{i,t+1}$ - $X_{i,t}$ respectively, all variables are divided by total assets. The dependent variable is the firm market value $V_{i,t}$, which is the sum of the market value of equity and the book value of short- and long-term debt. $L_{i,\,t}$ is firm liquid assets (total cash holdings), thus $dL_{i,t}$ and $dL_{i,t+1}$ represent lagged and lead cash level changes. Other variables include $E_{i,t}$, earnings before extraordinary items plus interest, deferred taxes, and investment taxes; $NA_{i,t,}$ net total assets; $RD_{i,t}$, R&D expenses; $I_{i,t,}$ interest expenses and $D_{i,t,}$ total cash dividends. Particularly, the lead changes in cash holdings $dL_{i,t+1}$ is developed by (Fama & French, 1998) to absorb expectations about cash changes that may affect firm value, Pinkowitz et al. (2006) address this issue by using the cash levels instead of changes in lagged and lead cash levels. The model becomes:

[15] See Appendix for definitions and descriptions of cash and cash equivalents (*ch*) and short-term investments (*ivst*) from Compustat.

$$V_{i,t}=\alpha+\beta_1 E_{i,t}+\beta_2 dE_{i,t}+\beta_3 dE_{i,t+1}+\beta_4 dNA_{i,t}+\beta_5 dNA_{i,t+1}+\beta_6 RD_{i,t}$$
$$+\beta_7 dRD_{i,t}+\beta_8 dRD_{i,t+1}+\beta_9 I_{i,t}+\beta_{10} dI_{i,t}+\beta_{11} dI_{i,t+1}+\beta_{12} D_{i,t}$$
$$+\beta_{13} dD_{i,t}+\beta_{14} dD_{i,t+1}+\beta_{15} dV_{i,t+1}+\beta_{16} L_{i,t}+\varepsilon_{i,t} \quad (2\text{-}2)$$

Where β_{16} is the marginal value of one dollar. In the investigation of the cash reserves that include long-term financial assets, Duchin et al. (2017) also follow the second modified model of Pinkowitz et al. (2006), and the model evolves to:

$$V_{i,t}=\alpha+\beta_1 E_{i,t}+\beta_2 dE_{i,t}+\beta_3 dE_{i,t+1}+\beta_4 dNA_{i,t}+\beta_5 dNA_{i,t+1}+\beta_6 RD_{i,t}+\beta_7 dRD_{i,t}+\beta_8 dRD_{i,t+1}$$
$$+\beta_9 I_{i,t}+\beta_{10} dI_{i,t}+\beta_{11} dI_{i,t+1}+\beta_{12} D_{i,t}+\beta_{13} dD_{i,t}+\beta_{14} dD_{i,t+1}$$
$$+\beta_{15} dV_{i,t+1}+\beta_{16} FinancialAssets_{i,t}+\beta_{17} RiskyFinancialAssets_{i,t}+\varepsilon_{i,t} \quad (2\text{-}3)$$

Where the sum of *FinancialAssets* and *RiskyFinancialAssets* consists of the cash holdings measured traditionally and long-term investments. Hence, following Duchin et al. (2017), the baseline model specifies as:

$$V_{i,t}=\alpha+\beta_1 Cash_{i,t}+\beta_2 FinancialAssets_{i,t}+\beta_3 E_{i,t}+\beta_4 dE_{i,t}+\beta_5 dE_{i,t+1}+\beta_6 dNA_{i,t}+\beta_7 dNA_{i,t+1}$$
$$+\beta_8 RD_{i,t}+\beta_9 dRD_{i,t}+\beta_{10} dRD_{i,t+1}+\beta_{11} I_{i,t}+\beta_{12} dI_{i,t}+\beta_{13} dI_{i,t+1}$$
$$+\beta_{14} D_{i,t}+\beta_{15} dD_{i,t}+\beta_{16} dD_{i,t+1}+\beta_{17} dV_{i,t+1}+year+fe_{i,t}+\varepsilon_{i,t} \quad (2\text{-}4)$$

Where the variables concerned are *Cash* and *FinancialAssets*. Following the model *2-2* from Pinkowitz et al. (2006), β_1 and β_2 capture the changes in firm value with one dollar increase in cash and short-term investments, namely the marginal value of one dollar of cash and short-term investments respectively. All other variable definitions are identical, whereas specific calculation varies in other studies, in this chapter, the market value of the firm $V_{i,t}$ is calculated by Compustat items as *prcc_f* * *csho* + *dlc* + *dltt*; earnings before extraordinary items $E_{i,t}$ is the sum of *ib*, *xint*, *txdi* and *itc*; net total assets $NA_{i,t}$ is *at* minus *che*; dividend $D_{i,t}$ is measured by *dvc*; and interest expenses $I_{i,t}$ is *xint*. All variables are deflated by the firm total assets *at*. Additionally, the model controls firm fixed effects, and time trends by adding the *year* indicator, as indicated by Bates et al. (2018) that there is a long-run change in overall cash holding value.

The second approach is developed by M. Faulkender and Wang (2006). The model specifies as follow:

$$r_{i,t}\text{-}R^{B}_{i,t}=\gamma_0+\gamma_1\frac{\Delta C_{i,t}}{M_{i,t-1}}+\gamma_2\frac{\Delta E_{i,t}}{M_{i,t-1}}+\gamma_3\frac{\Delta NA_{i,t}}{M_{i,t-1}}+\gamma_4\frac{\Delta RD_{i,t}}{M_{i,t-1}}+\gamma_5\frac{\Delta I_{i,t}}{M_{i,t-1}}+\gamma_6\frac{\Delta D_{i,t}}{M_{i,t-1}}+\gamma_7\frac{C_{i,t-1}}{M_{i,t-1}}$$
$$+\gamma_8 L_{i,t}+\gamma_9\frac{NF_{i,t}}{M_{i,t-1}}+\gamma_{10}\frac{C_{i,t-1}}{M_{i,t-1}}*\frac{\Delta C_{i,t}}{M_{i,t-1}}+\gamma_{11}L_{i,t}*\frac{\Delta C_{i,t}}{M_{i,t-1}}+\varepsilon_{i,t} \quad (2\text{-}5)$$

Where ΔX is the difference between the current and lagged value of variables. $R_{i,t}$ is stock return and $R_{i,t}$ is the benchmark stock return of Fama and French 25 portfolios formed on size and book-to-market ratio. $C_{i,t}$ is cash holdings, $L_{i,t}$ is market leverage and $NF_{i,t}$ is net financing. This model shares similarities with that of Fama and French (1998). It also controls firm characteristics including earnings before extraordinary items plus interest, deferred taxes, and investment taxes ($E_{i,t}$), net total assets ($NA_{i,t}$), R&D expenses ($RD_{i,t}$), interest expenses ($I_{i,t}$), total cash dividends ($D_{i,t}$). All independent variables except leverage ($L_{i,t}$) are deflated by lagged market value of firm eruqity ($M_{i,t-1}$). Because the dependent variable represents the excess stock return, γ_1 gauges the average value of one additional dollar of cash holdings in a non-levered and zero-cash firm from the market view. To incorporate the effects of levels of cash holdings and leverage, the marginal value of one dollar of cash holdings is computed as $\gamma_1 + \gamma_{10} * \bar{C}_{i,t} + \gamma_{11} * \bar{L}_{i,t}$, where $\bar{C}_{i,t}$ and $\bar{L}_{i,t}$ is the mean value of cash holdings and leverage respectively.

However, the main tests only use the Pinkowitz et al. (2006) model, there are three reasons. First, since most studies go with the M. Faulkender and Wang (2006) approach, it is intriguing to use the alternative method. Second, because the dependent variable of (Pinkowitz et al., 2006) is the market value of the firm, the coefficients of cash or short-term investments directly reflect their value through how the market decides the contribution of cash and short-term investments on firm value. Third, a recent paper by Halford et al. (2021) casts doubt on the results estimated via M. Faulkender and Wang (2006) equation. Specifically, they find the gaps between their benchmark cash value and estimates from the M. Faulkender and Wang (2006) method are enormous and pervasive. Therefore, the (Pinkowitz et al., 2006) approach is the prior consideration for all related tests.

2.4.4 Descriptive Statistics

Table 2-1 reports the descriptive statistics information on all key variables based on annual data from 1990 to 2019. The final sample contains 2512 firms and up to 22,652 firm-year observations. The variables of interest are *Cash* and *FianncialAssets*, measured by

Compsutat item *ch* and *ivst* respectively. The mean magnitude of cash is much higher than short-term investments, while the standard deviation is smaller, which indicates a relatively less divergent attitude towards holding short-term investments than cash.

Table 2-1 Descriptive Statistics

This table reports the summary statistics for the key variables. The sample is constructed based on CRSP/Compustat firms. The sample date ranges from January 1990 to December 2019. $X_{i,t}$ equals the value of X at time t, $dX_{i,t}$ is the difference of $X_{i,t} - X_{i,t-1}$, $dX_{i,t+1}$ represents the difference of $X_{i,t+1} - X_{i,t}$. *Cash* is cash and cash equivalents (*ch*), *FinancialAssets* is short-term investments (*ivst*), and *TotalCash* is total cash holdings (*che*). *V* is the market value of firms (*prcc_f* * *csho* + *dlc* + *dltt*). *E* is earnings before extraordinary items (*ib* + *xint* + *txdi* + *itc*). *NA* is net cash positions (*at* - *che*). *RD* is R&D expenses, missing values are set to zero. *I* indicates interest expenses (*xint*), and *D* is cash dividend (*dvc*). All variables are deflated by total assets (*at*).

	(1) *Mean*	(2) *Std. Dev*	(3) *Min*	(4) *Max*	(5) *Observations*
Cash	0.129	0.158	-0.00584	0.995	23,020
FinancialAssets	0.0472	0.118	0	0.983	23,020
TotalCash	0.177	0.206	-0.00161	1	23,020
V	1.804	2.903	0.00448	208.4	23,020
dV_{t+1}	0.273	2.238	-109.1	97.05	23,020
E	-0.00534	0.383	-28.45	2.223	23,020
dE	0.0148	0.566	-6.191	62.33	23,020
dE_{t+1}	0.0136	0.377	-28.44	29.45	23,020
dNA	0.0367	0.398	-37.31	0.971	23,020
dNA_{t+1}	0.102	0.566	-0.999	44.06	23,020
RD	0.0454	0.158	-0.00393	7.825	23,020
dRD	0.000254	0.135	-11.44	5.239	23,020
dRD_{t+1}	0.00129	0.0839	-7.490	1.472	23,020
I	0.0176	0.0681	-0.00431	6.774	23,020
dI	-0.000270	0.128	-18.42	2.070	23,020
dI_{t+1}	0.00158	0.0744	-6.646	6.428	23,020
D	0.0146	0.0399	-0.00726	1.458	23,020
dD	0.000484	0.0423	-1.767	1.458	23,020
dD_{t+1}	0.00124	0.0580	-1.458	6.701	23,020

2.5 Empirical Results

2.5.1 Baseline Regressions

This section tests hypothesis 1. Presumably, cash is evaluated higher than short-term investments. Firms build cash reserves in case external financing is expensive or unavailable, so they can be self-sufficient whenever liquidity is needed. However, short-term investments are not flexible and cheap. First, although short-term investments held by firms mostly are securities with high ratings, liquidation of these assets needs time (Azar et al., 2016), which means they may not provide liquidity in time. Second, liquidation of short-term investments probably suffers a loss in value caused by interest rate risks and transaction costs (Cardella et al., 2021), and firms do not liquidate until maturity. In the sense of providing liquidity, short-term investments can be as costly as external financing, for firms that need great internal liquidity they barely hold short-term investments (Cardella et al., 2021; Duchin et al., 2017). In contrast, cash serves liquidity needs unconditionally. Consequently, cash is expected to be more valuable than short-term investments considering it outperforms short-term investments to provide immediate and low-cost liquidity.

To determine the value of different types of cash holdings, this section runs regressions through the baseline model (4). There are two tests, the first test considers cash and short-term investments separately, and the two variables of interest are *Cash* and *FinancialAssets*, which are measured by Compustat items *ch* and *ivst* respectively. The second test examines the value of total cash holdings by combining *Cash* and *FinancialAssets* in the model. In other words, the total cash holdings are the sum of cash and short-term investments, i.e., the conventional measure of cash holdings *TotalCash*, Compsustat item *che* scaled by total assets.

Table 2-2 presents the results. Column 1 shows the results of the first test. The coefficients of *Cash* and *FinancialAssets* indicate that one dollar of cash is worth 1.56, and a dollar of short-term investments is 1.02, so the value of cash is approximately 50 cents higher than short-term investments per dollar, consistent with Cardella et al. (2021) that cash holdings with less short-term investments are more valuable. The estimates suggest at the mean level, where the precautionary motive drives an increase of cash holdings (Opler et al., 1999), cash is more valuable because it can fulfil precautionary needs by supplying immediate liquidity and enhance firm value, whereas short-term investments are illiquid and are not directly available for value creation.

Column 2 shows the results of the second test. The coefficient of *TotalCash* shows one dollar

is valued at 1.37 on average. The estimate is slightly higher than those in extant studies, M. Faulkender and Wang (2006) consider the marginal value of one dollar of cash to be 0.94, Pinkowitz and Williamson (2004) deduce a value of 1.2 per dollar. There can be two reasons for this divergence. First, the value of cash is increasing over time (Bates et al., 2018). The sample of M. Faulkender and Wang (2006) contains many firm-years before 1980, the year after which firms start to increase cash holdings and increase spending on innovation (Graham & Leary, 2018; He & Wintoki, 2016), that is, the surge in cash value comes to the surface since 1980s and exceeds its face value in 1990s because of emerging innovative firms (Bates et al., 2018; Bates et al., 2009). The sample covers more recent firm years, if the trend of value increase in cash holdings continues, it is reasonable that the estimate in this chapter is higher. Second, cash holdings are more valuable in regions with better country-level governance and investor protection (A. Dittmar & Mahrt-Smith, 2007; A. Dittmar et al., 2003; Frésard & Salva, 2010; Haw et al., 2011; Pinkowitz et al., 2006). This chapter only includes U.S. publicly traded firms, and regulations of the U.S. market by imposing strict monitoring, which prominently increases the value of cash (Frésard & Salva, 2010).

Overall, the results agree with hypothesis 1, cash is more valuable than short-term investments, and so are total cash holdings.

Table 2-2 The Value of Non-cash Cash Holdings: Baseline Regressions

This table reports the regression estimation of the value of cash holdings. The dependent variable of all regressions is the market value of firm *V* (*prcc_f* * *csho* + *dlc* + *dltt*). The key independent variables are cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*) in column 1, total cash holdings *TotalCash* (*che*) in column 2. All variables are deflated by total assets (*at*). Column 1 reports the value of cash and short-term investments at mean level. Column 2 reports the value of total cash holdings at mean level. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)
V (*Dependent Var.*)	*Cash & FinancialAssets*	*Total Cash Holdings*
Cash	1.557***	
	(0.130)	
FinancialAssets	1.016***	
	(0.164)	
TotalCash		1.372***
		(0.114)
E	0.909***	0.906***
	(0.0730)	(0.0730)
dE	0.411***	0.416***
	(0.0350)	(0.0350)
dE_{t+1}	0.445***	0.448***
	(0.0490)	(0.0490)
dNA	0.126***	0.124***
	(0.0306)	(0.0306)
dNA_{t+1}	0.351***	0.352***
	(0.0209)	(0.0209)
RD	16.52***	16.54***
	(0.189)	(0.188)
dRD	-1.700***	-1.687***
	(0.144)	(0.144)
dRD_{t+1}	16.34***	16.35***
	(0.233)	(0.233)
I	0.794***	0.800***
	(0.216)	(0.216)
dI	-0.992***	-0.980***
	(0.0975)	(0.0974)
dI_{t+1}	2.053***	2.051***
	(0.171)	(0.171)
D	3.768***	3.768***
	(0.483)	(0.484)
dD	-1.722***	-1.698***
	(0.326)	(0.326)
dD_{t+1}	0.857***	0.859***
	(0.257)	(0.257)
V_{t+1}	-0.197***	-0.197***
	(0.00600)	(0.00600)
Year	-0.00706***	-0.00665***
	(0.00194)	(0.00194)
Firm Fixed Effects	Yes	Yes
Observations	23,020	23,020
R^2	0.385	0.385

2.5.2 Impacts of Debt Retirement

The baseline test shows that generally the value of cash and short-term investments are different, and the value of cash is greater, as short-term investments are less liquid, which in turn is compensated by higher yields (Cardella et al., 2021; Duchin et al., 2017). This section subsequently addresses this illiquidity by investigating how the value of the composition of cash holdings varies with debt and time.

Utilizing the debt of firms is because the repayments should be in highly liquid cash-like assets, illiquid assets should be liquidated in advance, hence the value difference origins from illiquidity would be exposed with near-term payments due.

Specifically, if firms have greater proportions of debt maturity expiring soon, there should be less value allocated to cash holdings, which must be used to pay back debt instead of creating value. M. Faulkender and Wang (2006) find highly levered firms have a lower value on their cash holdings, because cash holdings will be distributed to creditors instead of enhancing firm value, incurring a discount from shareholders' view. They determine a dollar worth 1.47 in a firm with no cash holdings and leverage, but the value decreases as cash balance size and leverage increase, and particularly, a dollar in an all-equity-funded firm is always worth more than a levered firm. Since common lending does not grant debtholders the privilege of monitoring except tools like credit lines, debtholders can require deposits from borrowers to secure future repayment, especially for companies with overconfident managers who prefer risky projects (Y. Liu & Mauer, 2011; Phan et al., 2017), which increases unavailable cash holdings with a lower value. Unlike pure cash that can be used immediately, Cardella et al. (2021) find that firms liquidate short-term investments in response to debt amount due to avoid default risk, this illiquidity and conversion no doubt add additional costs to holdings the assets. Therefore, with more debt repayments due, the less value should shareholders give to cash, and even lower for short-term investments.

Then the model estimates the value of cash and cash holdings in firms with debt payments due in the next five years respectively. The results are given in Table 2-3. Column 1 in panel B of Table 2-3 shows that in a firm with debt payment in a year, a dollar of cash is worth 0.95, and no value for short-term investments. This suggests that the value of cash is higher because it can be used to retire debt, while short-term investments with an extra step of liquidation become less available for debt repayment. In panel A, column 1 shows that in a firm without debt pressure, a dollar of cash worth 2.4 and 1.9 for short-term investments, the value of cash is still higher than for short-term investments. This is like baseline results, without debt, shareholders would expect value creation of cash through investments, of

which the returns should be higher than yields of short-term investments, shareholders thus value cash more than short-term investments.

From columns 2 to 5 of both panels A and B, it is apparent that the gaps between the value of cash and short-term investments are persistent, although the value of short-term investments approaches cash across time, especially for firms with debt. Another trend is that in panel A, the value of both cash and short-term investments decreases with time for firms without immediate debt payment requirements, in particular, the value of cash peaks at 2.59 per dollar in the second year and declines afterwards, consistent with Graham (2022) who discovers that firms can only predict accurate future financial plans up to two years, which indicates the opportunity costs of cash holdings saving for long-distant future. In contrast, in panel B, for firms with known debt repayments in the future, the value of cash in the following years is predicted to be higher than the current year. And for short-term investments, the value is increasing with the extension of the horizon, especially in years 4 and 5. The maturity of (planned) short-term investments likely coincides with the time of debt retirements, firms can secure future funding whilst taking advantage of the extra yields of short-term investments.

Furthermore, Panel C shows the *p*-values of the difference in the value of the composition of cash holdings between firms that pay and do not pay the debt. The value of cash and short-term investments is always greater for firms without debt obligation. Intuitively, the greater value of cash holdings among firms without debt implies that the cash holdings benefit shareholders, not debtholders (M. Faulkender & Wang, 2006), even for illiquid short-term investments, which eventually increases shareholder wealth after maturity or being liquidated, instead of paying debts. However, the difference is only significant for the first two years, which again explains the limitation of the forecast of financial plans (Graham, 2022).

In all, the results are consistent with hypothesis 2, cash is worth more than short-term investments when firms need to pay debts soon, and this value difference diminishes over time.

Table 2-3 The Value of Non-cash Cash Holdings: Debt Retirement

This table reports the regression estimation of the value of cash holdings based on subsamples grouped by whether firms have debt retirement status. Debt repayments is measured by whether firms have debt due in the next five years (*dd1, dd2… dd5*). The dependent variable of all regressions is the market value of firm *V* (*prcc_f* * *csho* + *dlc* + *dltt*). The key independent variables are cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*). All variables are deflated by total assets (*at*). *Panel A* reports the estimation of firms with no debt payment due. *Panel B* reports the estimation of firms with debt payments due. *Panel C* reports the *p*-values of the difference in the coefficients of *Cash* and *FinancialAssets* between firms with and without debt in each year. For brevity, only the variables of interest are presented. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)
V (*Dependent Var.*)	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
			Panel A No Debt Due		
Cash	2.402***	2.585***	1.849***	2.009***	1.617***
	(0.271)	(0.279)	(0.299)	(0.267)	(0.250)
FinancialAssets	1.899***	1.891***	1.519***	1.446***	1.049***
	(0.320)	(0.327)	(0.357)	(0.322)	(0.301)
Year	-0.00777	-0.0125*	-0.0140**	-0.0151**	-0.0133**
	(0.00603)	(0.00657)	(0.00704)	(0.00611)	(0.00545)
Control Variables	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	6868	6602	7051	8116	9055
R^2	0.363	0.350	0.478	0.475	0.464
			Panel B With Debt Due		
Cash	0.950***	1.046***	1.261***	0.968***	1.129***
	(0.154)	(0.155)	(0.119)	(0.124)	(0.125)
FinancialAssets	0.0205	-0.604***	-0.0408	0.718***	1.063***
	(0.213)	(0.219)	(0.170)	(0.178)	(0.182)
Year	-0.00460**	0.00146	-0.00392***	-0.00158	-0.00183
	(0.00182)	(0.00173)	(0.00128)	(0.00126)	(0.00122)
Control Variables	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	15,722	13,474	12,895	11,914	10,681
R^2	0.503	0.630	0.392	0.195	0.150
			Panel C p-values		
Cash	0.000	0.000	0.293	0.771	0.559
FinancialAssets	0.000	0.000	0.329	0.976	0.0909

2.5.3 Impacts of Short-term Liquidity Needs

This section next investigates hypothesis 2, which believes low liquidity needs result from rare growth options making short-term investments more valuable.

Sections 4.1 and 4.2 have proved that cash is worth more than short-term investments. However, it does not explain why firms put money into investing short-term investments. Azar et al. (2016) find since the 1980s, firms earn higher interest on liquid assets, which indicates firms' alternative needs for cash management. In contrast to cash that trades low interest for high liquidity, short-term investments earn higher yields but sacrifice liquidity (Cardella et al., 2021). According to the researchers, the position of short-term investments that firms held depends on the trade-off between the costs, i.e., reduced liquidity and benefits (higher yields) of short-term investments.

Under the precautionary motive theory, liquidity always weighs over yields as providing liquidity is the top priority, which creates higher value for cash. Conversely, as the previous section shows that the gap between the value of cash and short-term investments reduces along with time, especially in debt-repaying firms, the value of both becomes very close. It is likely that under certain circumstances that the value of short-term investments exceeds that of cash, i.e. when yields of short-term investments predominate liquidity consideration. Such future funding is secured until the maturity of short-term investments, and the extra yields lower the costs of holding cash.

To test the conjecture, this section runs the baseline model by two subsamples grouped by short-term liquidity need, which is proxied by the market-to-book ratio, firms with market to book ratio below the median go to the low-needs group, in contrast, the others fall into the high-needs group.

The results are given in Table 2-4, columns 1 and 2 demonstrate the low and high-needs groups respectively. Consistent with hypothesis 2, the value of short-term investments is slightly higher than cash for low short-term liquidity needs firms, cash is only worth 0.24 per dollar, and short-term investments are 0.29 per dollar. Firms with fewer growth opportunities in the near term are less likely to require cash to fund investments, subsequently the higher yields of short-term investments become more attractive to shareholders. On the contrary, cash is more valuable for more firms with high needs firms, one dollar of cash is worth 1.79, even higher than the benchmark value of 1.56, for these firms the demand for immediate liquidity is greater to undertake investments, consistent with the results of Cardella et al. (2021) and Duchin et al. (2017) that document short-term investments are held less by firms with more investment opportunities or other immediate

funding needs.

Column 3 gives the *p*-values for the difference in the value of cash and short-term investments between firms with high and fewer short-term liquidity needs. Shareholders assign higher value for cash in firms with greater liquidity needs, and lower for firms with fewer liquidity needs. However, it makes no difference to shareholders between one dollar of short-term investments in firms with fewer liquidity needs and firms with more liquidity needs. This explains that the holdings of short-term investments feature extra yields and reduced liquidity may not differ in cross-sectional comparisons among firms with different levels of liquidity needs. In other words, the low liquidity needs firms do not benefit from the extra yields more than the disadvantages high liquidity needs firms suffer from holding short-term investments.

In all, the evidence presented in Table 2-4 confirms hypothesis 3 that short-term investments can be more valuable when cash is not needed in the near future.

Table 2-4 The Value of Non-cash Cash Holdings: Short-term Liquidity Needs

This table reports the regression estimation of the value of cash holdings based on subsamples grouped by short-term liquidity needs. Liquidity needs is measured by market-to-book ratio (*at − ceq + (prcc_f * csho))/at*). The dependent variable of all regressions is the market value of firm *V* (*prcc_f * csho + dlc + dltt*). The key independent variables are cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*). All variables are deflated by total assets (*at*). Column 1 reports the value of cash and short-term investments for low liquidity needs firms. Column 2 reports the value of cash and short-term investments for high liquidity needs firms. Column 3 reports the *p*-values of difference in coefficients of *Cash* and *FinancialAssets* between firms with low and high liquidity needs. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
V (*Dependent Var.*)	*Low Liquidity Needs*	*High Liquidity Needs*	*p-values*
Cash	0.235***	1.782***	0.000
	(0.0298)	(0.239)	
FinancialAssets	0.293***	1.240***	0.420
	(0.0392)	(0.288)	
E	0.440***	1.282***	
	(0.0269)	(0.120)	
dE	-0.0372***	0.262***	
	(0.0128)	(0.0558)	
dE_{t+1}	0.289***	0.452***	
	(0.0199)	(0.0757)	
dNA	0.0945***	0.278***	
	(0.0114)	(0.0524)	
dNA_{t+1}	0.0456***	0.528***	
	(0.00438)	(0.0412)	
RD	0.485***	18.26***	
	(0.125)	(0.286)	
dRD	-0.0519	-2.725***	
	(0.0542)	(0.227)	
dRD_{t+1}	0.589***	17.80***	
	(0.134)	(0.346)	
I	0.426**	1.571***	
	(0.189)	(0.348)	
dI	-0.440***	-1.131***	
	(0.129)	(0.136)	
dI_{t+1}	0.210***	3.583***	
	(0.0360)	(0.334)	
D	1.047***	3.719***	
	(0.146)	(0.806)	
dD	-0.200**	-1.903***	
	(0.0886)	(0.523)	
dD_{t+1}	0.588***	0.486	
	(0.101)	(0.379)	
dV_{t+1}	-0.0516***	-0.208***	
	(0.00385)	(0.00850)	
Year	0.00266***	-0.00821**	
	(0.000395)	(0.00406)	
Firm Fixed Effects	Yes	Yes	
Observations	11,528	11,481	
R^2	0.101	0.437	

2.5.4 Impacts of Financial Constraints

In cross-section, the value of total cash holdings is typically higher for financially constrained firms (Aktas et al., 2019; Bates et al., 2018; Denis & Sibilkov, 2009; M. Faulkender & Wang, 2006; Kyröläinen et al., 2013; Y. Liu & Mauer, 2011; Phan et al., 2017). There are two reasons. First, financially constrained firms have less access to external financing. Second, financially constrained firms are more likely to suffer underinvestment. Cash holdings replenish the insufficient liquidity of financially constrained firms and allow them to undertake valuable projects, which alleviates underinvestment and increases firm value. Financially unconstrained firms can finance investments with external financing, so the role of cash holdings is less prominent.

Financially constrained firms therefore should prefer cash to short-term investments (Cardella et al., 2021) for the relative illiquidity nature of short-term investments. Due to heavy reliance on internal liquidity, illiquid assets can do no favour to the liquidity needs of financially constrained firms. The value of cash consequently should be higher than short-term investments for constrained firms. In financially unconstrained firms, cash holdings are less important, therefore the precautionary motive is relatively less strong, but the motive to lower the cost of carry is stronger. Hence, short-term investments with higher returns should be more attractive to shareholders of unconstrained firms, and the short-term investments thus should be valued higher.

The financial criterion adopted is the SA index developed by flowing Hadlock and Pierce (2010). It is computed by the equation $(- 0.737 * size) + (0.043 * size^2) - (0.040 * age)$, where size is firm size, measured by the natural logarithm of total asset size, and age is firm age, counted as the number of years of being publicly listed. Firms are sorted into constrained and unconstrained firms by the median value on a yearly basis, constrained firms are in the top group while the unconstrained firms fall into the bottom tercile.

The results are presented in Table 2-5. The value of cash in constrained firms is 2.69 per dollar and 2.32 per dollar for short-term investments. In financially unconstrained firms, one dollar of cash is only worth 0.45, but the value of one dollar of short-term investments achieves 1.27. Consistent with hypothesis 4, the value of cash is greater than short-term investments for financially constrained firms, whereas the value of short-term investments is higher than that of cash for unconstrained firms. The *p*-values in column 3 suggest that both the value of cash and short-term investments are higher in constrained firms than unconstrained firms, consistent with studies that find financial constraints create value differences in total cash holdings (Aktas et al., 2019; Bates et al., 2018; Denis & Sibilkov,

2009; M. Faulkender & Wang, 2006; Kyröläinen et al., 2013; Y. Liu & Mauer, 2011; Phan et al., 2017).

Overall, consistent with hypothesis 4, financial constraints prioritize liquidity needs over extra yields, therefore the value of cash is higher than short-term investments in constrained firms, but the opposite in unconstrained firms.

Table 2-5 The Value of Non-cash Cash Holdings: Financial Constraints

This table reports the regression estimation of the value of cash holdings based on subsamples grouped by financial constraints. The financial constraint criterion is *SA index*. The dependent variable of all regressions is the market value of firm *V* (*prcc_f* * *csho* + *dlc* + *dltt*). The key independent variables are cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*). All variables are deflated by total assets (*at*). Column 1 reports the value of cash and short-term investments for constrained firms. Column 2 reports the value of cash and short-term investments for unconstrained firms. Column 3 reports the *p*-values of difference in coefficients of *Cash* and *FinancialAssets* between financially constrained and unconstrained firms. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
V (*Dependent Var.*)	*Constrained*	*Unconstrained*	*p-values*
Cash	2.688***	0.450**	0.000
	(0.304)	(0.203)	
FinancialAssets	2.320***	1.274***	0.0961
	(0.381)	(0.246)	
E	-0.300**	4.713***	
	(0.137)	(0.217)	
dE	0.360***	-0.583***	
	(0.0641)	(0.122)	
dE_{t+1}	-0.173**	2.842***	
	(0.0868)	(0.134)	
dNA	0.307***	0.166*	
	(0.0572)	(0.0869)	
dNA_{t+1}	0.309***	0.253***	
	(0.0576)	(0.0459)	
RD	15.04***	6.023***	
	(0.366)	(0.725)	
dRD	-0.225	1.919**	
	(0.280)	(0.918)	
dRD_{t+1}	13.28***	10.32***	
	(0.449)	(0.638)	
I	3.354***	-2.850**	
	(0.997)	(1.376)	
dI	-2.663***	1.148	
	(0.800)	(1.750)	
dI_{t+1}	-0.470	0.836	
	(0.305)	(1.624)	
D	1.167	5.391***	
	(1.618)	(0.669)	
dD	-0.965	-2.316***	
	(0.861)	(0.374)	
dD_{t+1}	1.954*	1.335***	
	(1.101)	(0.392)	
dV_{t+1}	-0.191***	-0.102***	
	(0.0118)	(0.00988)	
Year	-0.0384***	0.00259	
	(0.00876)	(0.00240)	
Firm Fixed Effects	Yes	Yes	
Observations	5,866	5,918	
R^2	0.384	0.211	

2.5.5 Impacts of Corporate Governance

Hypotheses 2 and 3 reckon short-term investments are more valuable for higher yields to dominate liquidity needs, but hypothesis 4 stresses the indirect yields of illiquidity of short-term investments. Illiquidity of assets prevents managers from disgorging cash holdings inefficiently, thereby agency costs reduce with less waste of money, short-term investments become appealing to shareholders for cost-savings. Agency cost is another important feature that affects the value of cash holdings. Agency costs arise because of agency conflicts. More specifically, managers are supposed to be on behalf of shareholders' interest, they are delegated by shareholders and on a mission to maximize firm value, yet in this way, managers may not be personally beneficial, different stances and pursuing induce managers to seek private benefits at shareholders' costs, typically through value-decreasing projects (A. Dittmar & Mahrt-Smith, 2007; Tong, 2011) or stock repurchases in some cases (Haw et al., 2011).

Based on extant studies, there are two directions in alleviating agency costs and increasing the value of cash holdings. First, good governance at either the country-level or firm-level (A. Dittmar & Mahrt-Smith, 2007; Tong, 2011), detailed regulations and laws on investor protection (A. Dittmar et al., 2003; Haw et al., 2011) improve the value of cash holdings. From this perspective, agency costs are lessened due to discouragement by potential punishment. Managers are likely to be intimidated by the enforced penalty introduced by laws and monitoring, and shareholders are confident in controlling spending even if there is a considerable cash balance (Harford et al., 2008), which avoids participating in money waste activities. Second, the interests of managers and shareholders are aligned, such agency conflicts are smaller and agency costs naturally decline. According to Y. Liu and Mauer (2011) and Phan et al. (2017), managers are rewarded with company shares as they get promoted, and the interests of two parties align as managers become shareholders, consequently, the likelihood of money waste is lower. Reasonably, Harford et al. (2008) indicate that strong shareholder rights are typically accompanied by higher insider ownership, both stronger shareholder rights and insider ownership are positively related to the size of cash holdings, which are also linked to greater firm profitability and valuation. Therefore, cash holdings are more valuable when managers and shareholders share an identical objective.

Different from existing views, this chapter proposes that short-term investments build a natural barrier that prevents agency costs. As discussed previously, the value of cash is higher at the mean level or for firms with higher liquidity needs since cash is available immediately.

In contrast, firms must shift short-term investments to cash if they intend to spend these assets, the liquidation is also exposed to interest rate risks (Azar et al., 2016; Cardella et al., 2021). Therefore, these firms hold fewer short-term investments. Likewise, if short-term investments cannot fulfil ordinary firm liquidity needs, then short-term investments cannot be used to fund value-decreasing projects either, through which self-interested agents are likely to extract private benefits. This channel does not necessarily eliminate the manager-shareholder conflicts, i.e. it does not align the interest of them but reduces the intention of managers to waste money, thus mitigating agency costs. Hence, short-term investments are expected to be more valuable than cash in poorly governed firms, but the opposite in well-governed firms, as agency costs are greater in poorly governed firms.

To test hypothesis 4, this section runs the baseline model by subsamples grouped by corporate governance, which is proxied by insider ownership following (Denis & Sibilkov, 2009; Harford et al., 2008; Malmendier & Tate, 2005; Opler et al., 1999).

The results are provided by Table 2-6, columns 1 and 2 show the results for firms with poor and good governance respectively, low insider ownership indicates an inferior governance structure. Consistent with the expectations, column 1 shows the value of cash is lower than that of short-term investments in poorly governed firms, and in column 2, the value of cash in well-governed firms is significantly boosted; however, the value of short-term investments is insignificant. Short-term investments are more valuable in poorly governed firms, because the relatively complicated utilization process of short-term investments discourages spending, especially where the “additional liquidity needs” caused unwanted waste of cash holdings, extra yields further reduce the costs of carry, while in firms with good governance, the barrier for wasteful spending set by short-term investments is less necessary, which thus reflects no value for short-term investments. Hence, the results demonstrated confirm short-term investments are more valuable in low insider ownership firms and less valuable in high insider ownership firms, consistent with Harford et al. (2008) and Malmendier and Tate (2005), who suggest lower agency costs along with higher inside ownership and stronger shareholder rights. Column 3 suggests that the value difference in cross-section is highly significant.

In conclusion, the results verify hypothesis 5 that short-term investments are more valuable when insider ownership is lower, due to the possible impacts of liquidation in decreasing agency costs.

Table 2-6 The Value of Non-cash Cash Holdings: Corporate Governance

This table reports the regression estimation of the value of cash holdings based on subsamples grouped by corporate governance. Corporate governance is measured by levels of insider ownership. The dependent variable of all regressions is the market value of firm *V* (*prcc_f* * *csho* + *dlc* + *dltt*). The key independent variables are cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*). All variables are deflated by total assets (*at*). Column 1 reports the value of cash and short-term investments for poorly governed firms. Column 2 reports the value of cash and short-term investments for well governed firms. Column 3 reports the *p*-values of difference in coefficients of *Cash* and *FinancialAssets* between poorly governed and well governed firms. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
V (*Dependent Var.*)	*Poorly Governed*	*Well Governed*	*p-values*
Cash	1.031***	2.175***	0.000
	(0.225)	(0.291)	
FinancialAssets	1.215***	-0.0812	0.000
	(0.277)	(0.419)	
E	-0.0236	0.607***	
	(0.144)	(0.148)	
dE	-0.0128	0.493***	
	(0.0604)	(0.0581)	
dE_{t+1}	0.118	0.874***	
	(0.0948)	(0.113)	
dNA	-0.0655	0.132***	
	(0.0772)	(0.0376)	
dNA_{t+1}	0.0666***	0.467***	
	(0.0203)	(0.0427)	
RD	6.162***	16.29***	
	(0.342)	(0.383)	
dRD	-0.288	-3.749***	
	(0.256)	(0.291)	
dRD_{t+1}	5.416***	5.948***	
	(0.307)	(0.528)	
I	6.110***	-6.391***	
	(0.626)	(1.294)	
dI	-2.386***	1.357	
	(0.450)	(0.905)	
dI_{t+1}	2.860***	-3.924***	
	(0.318)	(1.111)	
D	3.381***	4.603***	
	(0.708)	(1.256)	
dD	-1.820***	-1.840***	
	(0.530)	(0.680)	
dD_{t+1}	-0.0502	1.498*	
	(0.189)	(0.772)	
dV_{t+1}	-0.254***	-0.365***	
	(0.0109)	(0.0156)	
Year	0.00956	0.0174*	
	(0.00653)	(0.0103)	
Firm Fixed Effects	Yes	Yes	
Observations	4738	4722	
R^2	0.257	0.481	

2.5.6 Cash, Short-term Investments and the Value of Corporate Investments

This part extends the tests in the previous section to explore the connections between cash holdings and the value of investments. Presumably, the value of cash and short-term investments differ as cash incurs agency costs, but short-term investments reduce such costs. In poorly governed firms, which are proxied by firms with low insider ownership, the value of short-term investments is higher than that of cash. Because when agency conflicts are greater, weakly controlled managers care even less about maximizing firm value; instead, they take advantage of discretionary cash to extract private benefits, such as investing in value-decreasing projects, as a result, cash brings agency costs rather than creating extra value for shareholders. Instead, firms benefit from the illiquidity of short-term investments to lower agency costs. Conversely, agency conflicts are smaller with increases in insider ownership, as more managers enter the group of shareholders, the interests of both two are aligned, and cash holdings are spent more efficiently. The job of lowering agency costs of short-term investments is less than expected, and the value of short-term investments decreases.

Briefly speaking, if managers regard cash and short-term investments to be different liquidity and take different strategies, then such information should be contained in cash holdings, consequently reflected by the performance of investments funded by these two liquidities.

Therefore, this section checks whether cash and short-term investments supported investment projects produce disparate impacts on company value. Since short-term investments are likely to be effective in constraining money waste, short-term investments funded corporate investments are expected to be profitable, i.e., investments funded by short-term investments are highly valued by shareholders. Because to undertake the investments, managers sacrifice the yields and risk loss in value of short-term investments through liquidation, the return must be high enough to convince managers the investments are worth the value. Those funded by cash are less significant to firm value, or can negatively contribute to firm value, given Harford et al. (2008) detect a negative relation between excess cash and profitability, cash-financed investments are more likely to be value-decreasing.

To investigate the story, the tests follow Kyröläinen et al. (2013), who estimate the value of investments by exploiting the *dNA* variable in the Pinkowitz et al. (2006) model, where *dNA* represents the yearly changes in the net total assets and is used to proxy changes in investments. Following this idea, the model manages to decide if investments made through cash or short-term investments create positive impacts by observing their contributions to changes in firm value.

The estimates are given by Table 2-7, for brevity, only variables of interest are presented. First, the coefficients of *dNA* in all three columns are positive and highly significant, which indicates investments help firms grow at the general level. In column 1, the model interacts liquidity variables with *dNA*, and governance proxy, *Insider*, which is raw ownership of insiders. The coefficients of the first two interactions (*dNA*Cash* and *dNA*FinancialAssets*) indicate in a zero-insider ownership firm, one standard deviation increase in cash-supported investments decreases the firm value by 0.065 dollars, and one standard deviation increase in investments funded by short-term investments increase firm value by 0.35 dollars, which are consistent with the predictions. Interactions with corporate governance are also in line with expectations, with more managers sharing the same purpose of interest, the efficiency of cash spending is greater, the negativity on cash investments no longer exerts influence on firm value, and the value of investments backed by short-term investments are less valuable than before either.

In columns 2 and 3, *Cash* and *FinancialAssets* are replaced by cash ratio and short-term investments ratio respectively, the two ratios are defined as the cash and short-term investments divided by total cash holdings. Consistent with results in column 1, the higher percentage of cash in total cash holdings held, the lower value investments have, causing the firm value to drop, while the coefficient of short-term investments ratio and investments tells firm value increase with short-term investments positions in cash holdings among mean firms. Once again, after the corporate governance option is added, the results are reversed. Although the interaction of investments and cash ratio and insider ownership remains negative, the coefficient becomes extremely small and insignificant. And for the interaction features short-term investments ratio, the value of investments also become less valuable, which is in the anticipation.

In all, consistent with the projections, when cash and short-term investments contribute to increases in profitability in different directions, the results also confirm the value of investments made by cash and short-term investments differentiate, where the former cause loss and the latter earns money, which accounts for the gaps in value of cash holdings.

Table 2-7 The Value of Non-cash Cash Holdings: The Value of Investments

This table reports the regression estimation of the value of corporate investments. The tests use the same baseline model (4) but has a focus on the variable *dNA*. Following Kyröläinen et al. (2013), investments is measured by changes in non-cash assets *dNA*. The dependent variable of all regressions is the market value of firm *V* (*prcc_f * csho + dlc + dltt*). The key independent variable is investment *dNA* (*at - che*). Other key independent variables include two cash holding variables, cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*); two cash holding ratio variables, cash ratio *Cash Ratio* (*ch/che*), short-term investments ratio *FinancialAssets Ratio* (*ivst/che*), and an corporate governance variable, insider ownership *Insider*. All variables except the cash holding ratio variables and the governance variable are deflated by total assets (*at*). Column 1 reports the value of investments from regressions using raw cash holding items. Columns 2 reports the value of investments from regression using cash holding ratio items (*Casn Ratio*). Columns 3 report3 the value of investments from regression using cash holding ratio items (*FinancialAssets Ratio*). For brevity, only the variables of interest are presented. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
V (*Dependent Var.*)	*Pooled*	*Cash*	*FinancialAssets*
Cash	1.830***	1.844***	1.822***
	(0.191)	(0.189)	(0.186)
FinancialAssets	0.887***	0.800***	0.796***
	(0.258)	(0.255)	(0.254)
dNA	0.325***	1.007***	0.127***
	(0.0739)	(0.255)	(0.0317)
*dNA*Cash*	-0.411**		
	(0.186)		
*dNA*FinancialAssets*	2.973***		
	(0.865)		
*dNA*Cash Ratio*		-0.827***	
		(0.274)	
*dNA*FinancialAssets Ratio*			1.278***
			(0.310)
*dNA*Cash*Insider*	0.000774		
	(0.00306)		
*dNA*FinancialAssets*Insider*	-0.0174		
	(0.0751)		
*dNA*Cash Ratio*Insider*		-0.00101	
		(0.00142)	
*dNA*FinancialAssets Ratio*Insider*			-0.0418**
			(0.0189)
dNA_{t+1}	0.218***	0.216***	0.214***
	(0.0219)	(0.0219)	(0.0219)
Insider	0.00141	0.00118	0.00107
	(0.00301)	(0.00302)	(0.00302)
Year	0.0146**	0.0142**	0.0137**
	(0.00610)	(0.00611)	(0.00611)
Control Variables	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
Observations	9460	9447	9447
R^2	0.352	0.350	0.351

2.5.7 Further Discussion

This chapter concentrates on two general compositions of cash holdings, the cash and cash equivalent component and short-term investments component. Each component can be further decomposed into detailed financial assets. According to Compustat[16], cash and cash equivalent include ten types of financial assets, for example, receivables and certificates of deposit; and there are seventeen types of financial assets under short-term investments, such as commercial paper and marketable securities. It is likely that firms may benefit from one specific financial asset instead of one general component.

Cardella et al. (2021) show that firms actively adjust the compositions of cash holdings by trading off their demand for liquidity and yields. Firms are more likely to hold short-term investments for high yields when they expect no internal liquidity needs, but they convert short-term investments to cash and cash equivalent when they expect increased demand for liquidity. This indicate that the short-term investments that firms hold should provide high yields, but also remain the flexibility of providing liquidity. This flexibility may be translated to easy shift of short-term investments into cash and cash equivalent because only the latter is readily available for corporate investments, operating or other firm activities.

According to hand collected data from Cardella et al. (2021)[17], U.S. corporate bonds is the most common short-term investments that firms hold. It accounts for more than a third of total short-term investments (35.29%) and 19.03% of total cash holdings, followed by U.S. treasury bills and other municipal debt, which explains 28.33% and 12.51% of total short-term investments. Comparatively, corporate bonds typically offer higher yields due to greater risks (than U.S. treasury bills), meanwhile, the rating requirements on these corporate bonds suggest the risks are relatively small. Additionally, the transaction cost of corporate bonds is only half of municipal bonds. These conditions make corporate bonds stand out for easy shifting to cash and cash equivalent. Therefore, corporate bond is likely to be the most beneficial short-term investment to firms. However, availably of data doesn't allow further

[16] See the Table 2-12 in Appendix B for the full description of cash and cash equivalent and short-term investments from Compustat.

[17] The information of detailed holdings of each financial asset is not available from Compustat or other database. Firms disclose the fair value of cash and cash equivalent and short-term investments on their annual reports by legal requirements, but the disclosure of specific financial assets is voluntary (Cardella et al., 2021). The voluntary disclosure may follow different standards that leads to inaccuracy. For instance, (Duchin et al., 2017) show that Intel report the fair value of each item of cash and cash equivalent expect actual cash, the fair value of these assets without pure cash sums up to 7,885 million, mismatching the total value of 8,478 million of cash and cash equivalent, the gap of 593 million may be the missing fair value of pure cash.

discussion, this chapter leaves the questions for future exploration.

2.6 Robustness

2.6.1 Alternative Methodology

This part verifies the results from the baseline tests by using alternative methods. Specifically, this part assesses the results with the same dataset[18] from Compustat but follows the approach introduced by M. Faulkender and Wang (2006). Like Duchin et al. (2017) who regard safe and risky liquidity separately in their model, the liquidity variable in model (5) (M. Faulkender & Wang, 2006) is decomposed into two variables that gauge cash and short-term investments, i.e., *Cash* and *FinancialAssets*, which are identical to the variables in the main tests. The modified alternative specifies as:

$$\begin{aligned} r_{i,t}\text{-}R^{B}_{i,t} = \gamma_0 + \gamma_1 \frac{\Delta Cash_{i,t}}{M_{i,t-1}} + \gamma_2 \frac{\Delta FinancialAssets_{i,t}}{M_{i,t-1}} + \gamma_3 \frac{\Delta E_{i,t}}{M_{i,t-1}} + \gamma_4 \frac{\Delta NA_{i,t}}{M_{i,t-1}} + \gamma_5 \frac{\Delta RD_{i,t}}{M_{i,t-1}} + \gamma_6 \frac{\Delta I_{i,t}}{M_{i,t-1}} \\ + \gamma_7 \frac{\Delta D_{i,t}}{M_{i,t-1}} + \gamma_8 \frac{Cash_{i,t-1}}{M_{i,t-1}} + \gamma_9 L_{i,t} + \gamma_{10} \frac{NF_{i,t}}{M_{i,t-1}} + \gamma_{11} \frac{Cash_{i,t-1}}{M_{i,t-1}} * \frac{\Delta Cash_{i,t}}{M_{i,t-1}} \\ + \gamma_{12} L_{i,t} * \frac{\Delta Cash_{i,t}}{M_{i,t-1}} + \gamma_{13} \frac{FinancialAssets_{i,t-1}}{M_{i,t-1}} * \frac{\Delta FinancialAssets_{i,t}}{M_{i,t-1}} \\ + \gamma_{14} L_{i,t} * \frac{\Delta FinancialAssets_{i,t}}{M_{i,t-1}} + year + fe_{i,t} + \varepsilon_{i,t} \quad (2\text{-}6) \end{aligned}$$

Where the dependent variable is excess returns of firms, $r_{i,t}$ is firm-specific returns, while $R_{i,t}$ is the benchmark return obtained from Fama and French 25 portfolio based on size and book-to-market ratio. The sample firms are partitioned into 25 groups on a yearly basis and each group is assigned the matched benchmark return.

For terms in the right side of the equation, $\Delta X = X_t - X_{t-1}$, variables $E_{i,t}$ is earnings before extraordinary items plus interest, deferred taxes, and investment taxes, $NA_{i,t}$ is net total assets, $RD_{i,t}$ is R&D expenses, $I_{i,t}$ is interest expenses and $D_{i,t}$ is total cash dividends, these are variables that are same as those in the main tests. $L_{i,t}$ is market leverage computed as the sum of long and short-term debt deflated by the sum of the market value of equity and long and

[18] The same original dataset as in the main tests is used in robustness check. The dataset is process separately, due to the different composition of the M. Faulkender and Wang (2006) model, the final processed dataset is slightly different.

short-term debt by following M. Faulkender and Wang (2006), and $NF_{i,t}$ is net financing. All variables except leverage is deflated by the lagged market value of equity.

Table 2-8 reports the results for hypothesis 1. The coefficients of *ΔCash* and *ΔFinancialAssets* in column 1 show that along with changes in cash holdings and leverage, the per dollar of cash worth 2.09 and per dollar of short-term investments worth 1[19] in a mean firm, which is consistent with the main results that cash is more valuable at the general level. Other hypotheses are also examined through the alternative method, all results are robust according to Table 2-9 and Table 2-10.

[19] The standard deviation of *Leverage* is 0.199, $Cash_{t-1}$ is 0.308 and 0.197 for $FinancialAssets_{t-1}$. Hence in column 1, the value of cash is 2.091 = 1.58 - 0.127 * 0.308 + 2.766 * 0.199, and the value of short-term investments is 1.004 = 1.704 + 0.139 * 0.197 - 3.651 * 0.199.

Table 2-8 Robustness: Full Sample

This table reports the robustness regression estimation of the value of cash holdings. This table repeats the baseline tests by using the alternative approach developed by M. Faulkender and Wang (2006). For all regressions, the dependent variable is the firm excess return, which is the difference between firm-specific return and benchmark return of Fama and French 25 portfolios formed on size and book-to-market ratio. The key independent variables are the changes in cash *ΔCash* (*ch*) and changes in short-term investments *ΔFinancialAssets* (*ivst*). Column 1 reports the value of cash and short-term investments at mean level. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)
Excess Return (*Dependent Var.*)	*Full Sample*
ΔCash	1.580***
	(0.116)
ΔFinancialAssets	1.704***
	(0.220)
ΔE	0.172***
	(0.0301)
ΔNA	-0.0290
	(0.0308)
ΔRD	3.215***
	(0.268)
ΔI	-0.541**
	(0.269)
ΔD	-0.508
	(0.373)
$Cash_{t-1}$	0.471***
	(0.0761)
$FinancialAssets_{t-1}$	0.385**
	(0.157)
Leverage	-1.748***
	(0.139)
NF	0.475***
	(0.0645)
$Cash_{t-1}$*ΔCash	-0.127***
	(0.0361)
*Leverage*ΔCash*	2.766***
	(0.267)
$FinancialAssets_{t-1}$*ΔFinancialAssets	0.139**
	(0.0546)
*Leverage*ΔFinancialAssets*	-3.651***
	(0.437)
Year	0.0112***
	(0.00293)
Firm Fixed Effects	Yes
Observations	13,049
R^2	0.107

Table 2-9 Robustness: Liquidity Needs, Corporate Governance, and Financial Constraints
This table reports the robustness regression estimation of the value of cash holdings. This table repeats the baseline tests by using the alternative approach developed by M. Faulkender and Wang (2006). The sample is grouped by liquidity needs, corporate governance and financial constraints respectively. For all regressions, the dependent variable is the firm excess return, which is the difference between firm-specific return and benchmark return of Fama and French 25 portfolios formed on size and book-to-market ratio. The key independent variables are the changes in cash *ΔCash* (*ch*) and changes in short-term investments *ΔFinancialAssets* (*ivst*). Columns 1 and 2 report the value of cash and short-term investments based on subsamples grouped by liquidity needs (M/B ratio). Columns 3 and 4 report the value of cash and short-term investments based on subsample grouped by corporate governance. Columns 5 and 6 report the value of cash and short-term investments based on the subsamples grouped by financial constraints (SA index). All regressions include firms fixed effects. For brevity, only the variables of interest are presented. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)
Excess Return (*Dependent Var.*)	*Low Liquidity Needs*	*High Liquidity Needs*	*Poorly Governed*	*Well Governed*	*Constrained*	*Unconstrained*
ΔCash	0.0860	3.220***	1.812***	0.803***	-1.238***	1.909***
	(0.185)	(0.233)	(0.138)	(0.234)	(0.335)	(0.154)
ΔFinancialAssets	2.177***	1.702***	2.492***	0.252	2.527***	2.501***
	(0.302)	(0.355)	(0.219)	(0.305)	(0.475)	(0.232)
$Cash_{t-1}$*ΔCash*	0.0342	-0.643***	0.684***	-0.0710	1.180***	0.0928
	(0.0470)	(0.0941)	(0.106)	(0.237)	(0.128)	(0.136)
*Leverage*ΔCash*	3.217***	4.346***	-2.879***	0.148	6.579***	-0.771**
	(0.397)	(0.628)	(0.330)	(0.549)	(0.601)	(0.336)
$FinancialAssets_{t-1}$	0.179***	1.554*	0.101	-0.0467	0.236*	0.00138
*ΔFinancialAssets	(0.0612)	(0.839)	(0.245)	(0.238)	(0.123)	(0.189)
Leverage	-4.517***	-6.594***	-3.448***	-0.489	-7.858***	-3.123***
*ΔFinancialAssets	(0.536)	(1.358)	(0.614)	(0.718)	(1.102)	(0.497)
Year	0.0182***	0.00805**	0.0105*	0.0190*	0.0350**	-0.00532***
	(0.00471)	(0.00340)	(0.00629)	(0.0106)	(0.0139)	(0.00206)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6601	6545	3133	3127	3579	3591
R^2	0.116	0.247	0.376	0.120	0.202	0.324

Table 2-10 Debt Retirement

This table reports the robustness regression estimation of the value of cash holdings. This table repeats the baseline tests by using the alternative approach developed by M. Faulkender and Wang (2006). The sample is grouped by firm debt retirement status. For all regressions, the dependent variable is the firm excess return, which is the difference between firm-specific return and benchmark return of Fama and French 25 portfolios formed on size and book-to-market ratio. The key independent variables are the changes in cash *ΔCash* (*ch*) and changes in short-term investments *ΔFinancialAssets* (*ivst*). *Panel A* reports the value of cash and short-term investments for firms do not have long-term debt repayment due. *Panel B* reports the value of cash and short-term investments for firms have long-term debt repayment due. All regressions include firm fixed effects. For brevity, only the variables of interest are presented. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)
Excess Return (*Dependent Var.*)	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
			Panel A No Debt Due		
ΔCash	2.571***	1.919***	0.322	-0.133	1.120***
	(0.312)	(0.270)	(0.253)	(0.232)	(0.185)
ΔFinancialAssets	-0.0890	0.664*	0.859**	0.326	0.674**
	(0.409)	(0.357)	(0.358)	(0.344)	(0.334)
$Cash_{t-1}$*ΔCash*	-0.256**	-0.0334	0.633***	0.828***	0.214***
	(0.114)	(0.108)	(0.101)	(0.0956)	(0.0628)
*Leverage*ΔCash*	-3.636***	-5.421***	-0.128	1.497**	0.433
	(0.868)	(0.863)	(0.696)	(0.608)	(0.580)
$FinancialAssets_{t-1}$	4.111***	3.591***	3.097***	3.114***	3.069***
ΔFinancialAssets	(0.263)	(0.236)	(0.240)	(0.239)	(0.243)
*Leverage*ΔFinancialAssets*	-7.246***	-11.42***	-9.792***	-10.11***	-10.02***
	(1.087)	(0.907)	(0.771)	(0.746)	(0.741)
Year	0.0225***	0.0205***	0.0251***	0.0195***	0.0270***
	(0.00698)	(0.00686)	(0.00707)	(0.00662)	(0.00640)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	3935	4128	4449	5085	5620
R^2	0.170	0.163	0.156	0.166	0.148
			Panel B With Debt Due		
ΔCash	0.765***	1.755***	1.565***	1.475***	1.401***
	(0.161)	(0.195)	(0.197)	(0.200)	(0.218)
ΔFinancialAssets	1.063***	1.114***	0.784**	0.728**	0.849**
	(0.318)	(0.324)	(0.343)	(0.343)	(0.374)
$Cash_{t-1}$*ΔCash*	-0.274***	-0.613***	-0.662***	-0.651***	1.121***
	(0.0400)	(0.0399)	(0.0383)	(0.0373)	(0.155)
*Leverage*ΔCash*	4.952***	3.012***	3.215***	3.532***	0.524
	(0.341)	(0.382)	(0.379)	(0.371)	(0.453)
$FinancialAssets_{t-1}$	-0.00246	0.147**	-0.104*	-0.0588	-0.0719
ΔFinancialAssets	(0.0608)	(0.0617)	(0.0614)	(0.0581)	(0.0572)
*Leverage*ΔFinancialAssets*	-2.573***	-3.075***	0.198	0.278	-0.0484
	(0.558)	(0.626)	(0.671)	(0.651)	(0.679)
Year	0.00550	0.00361	0.00444	0.00471	-0.000250
	(0.00338)	(0.00323)	(0.00309)	(0.00292)	(0.00280)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	9211	9018	8697	8061	7526
R^2	0.139	0.143	0.167	0.182	0.214

2.6.2 Endogeneity

This chapter uses two approaches from Pinkowitz et al. (2006) and M. Faulkender and Wang (2006). Both methodologies regress firm value over a series of firm characteristics, while the former approach proxies firm value by its market value and uses cash levels as the liquidity variable, the latter approach measures firm value by firm excess stock returns and uses changes in cash as liquidity variable. Hence both methodologies obtain marginal value of cash holdings from the market view. This chapter does not recognise endogeneity issue for several reasons. First, consistent measure of cash holdings. The liquidity variables *Cash* and *Short-term Investments* are presented in fair value of cash holdings that shown in firm annual reports. All firms are listed in the U.S. market, they follow the same accounting rules and the same changes in accounting rules if there is any. Although Cardella et al. (2021) suggest firms may not specify every items they held as *Cash* or *Short-term Investments*, the total value of *Cash* or *Short-term Investments* shall be reported in the same way. Second, a reverse causality is unlikely. Rare literature raises concerns over a reverse causality since firm characteristics can affect firm value, whereas it is not necessarily that firm value will change firm characteristics in both valuation model. Especially Bates et al. (2018) explains that in the method of M. Faulkender and Wang (2006), excess returns driven results are not possibility acquirable[20]. Third, most endogeneity issues raised in literature of cash value are not about the methodology itself. For example, Aktas et al. (2019) estimate the impacts of CEO overconfidence on the value of cash holdings by following the model of M. Faulkender and Wang (2006), their endogeneity issue arises from the relation between the measure of CEO overconfidence and the excess returns, not the valuation model itself. Consequently, the results in this chapter are not likely distorted by endogeneity issues.

2.7 Conclusions

Current research has estimated the value of cash holdings by combining cash, cash equivalent and short-term investments together until some studies notice the nuance between cash and non-cash financial assets (Azar et al., 2016; Cardella et al., 2021; Duchin et al.,

[20] See Bates et al. (2018).

2017).

Starting from the concept of differentiating cash and short-term investments, this chapter extends the existing analysis by assessing the value of these two types of assets separately. In the assumptions, cash is more valuable than short-term investments overall, and this value gap enlarges with immediate needs. Because for firms that save cash for precautionary motives, cash outperforms short-term investments in immediate liquidity supply. The results show that generally, the value of cash is greater than short-term investments, especially when firms have debts to pay back in the next two years.

As the value gap between cash and short-term investments diminishes gradually, it is also likely that short-term investments are advantageous when immediate liquidity needs do not bother firms. Cash gets lower returns liquidity, while short-term investments get illiquidity for higher returns. When cash holdings are not expected to be deployed, firms find higher yields that are more attractive than liquidity, which makes short-term investments more valuable than cash. This chapter proposes several scenarios in which liquidity is less of a concern. First, when expansion in firm business is not anticipated. Holding cash is costly, as cash can only create less value through its interest returns rather than more value through investments. Put another way short-term investments earn higher yields and secure future funding. Second, when firms are not financially constrained. For unconstrained firms, shareholders generally value short-term investments more as these firms have access to low-cost external financing, while constrained firms that rely on internal liquidity put less value on short-term investments.

In addition, firms may find short-term investments are more valuable when immediate liquidity is not sought after because of agency costs other than yields. Easily shifted cash tempts undesired projects that decrease shareholder wealth to benefit managers. In contrast, barriers in the liquidation process of short-term investments, such as maturity and interest risk, deter money-wasting investments. Indeed, for poorly governed firms, the value of short-term investments is detected to be higher than cash, plus the greater value of projects funded by short-term investments.

There are limitations in this chapter. The tests focus on intra-firm comparisons of cash and short-term investments value, namely, the tests compare the value of cash to the value of short-term investments, instead of cross-sectional comparisons. For example, the value of short-term investments in firms with low liquidity needs is 0.29 per dollar, and 1.24 per dollar in firms with high liquidity needs, yet these two values are not statistically different from each other. Possibly, the benefit of extra yields in firms with low liquidity needs is not superior to the cost of reduced liquidity in firms with high liquidity needs. Yet in other cross-

section groups, such as those sorted by financial constraints or corporate governance, the differences in value are significant. There are no further explanations, and the questions are left for future exploration.

In sum, this study brings new insights into how cash holdings are valued when different parts of cash holdings are distinguished, it shows not only the value of cash and short-term investments varies under different premises, but also suggests the potential role of short-term investments in diminishing agency costs. Therefore, this chapter guides the new way in cash management.

Chapter 3

3 CEO Overconfidence and Stock Liquidity

3.1 Abstract

Chapter 3 studies the impacts of CEO overconfidence on firm stock liquidity and through which channels CEO overconfidence affects stock liquidity. On average, overconfident CEOs decrease trading discontinuity and price impacts on the stocks of their firms, which reveals a positive relationship between overconfidence and stock liquidity. Overconfident CEOs increase stock liquidity through their investment policies but not financial policies. Overconfident CEOs favour internal liquidity such as cash holdings, which facilitate money wastage behaviour. Instead, aggressive investment policies and preference for riskiness of overconfident CEOs mitigate underinvestment. The impacts of investment policies dominate the effects and earn positive feedback from the market.

3.2 Introduction

Managerial psychological beliefs, particularly overconfidence, have drawn increasing attention in recent studies of firm performance. Relative to rationality, overconfidence is a biased psychological state, but upward biased, which means individuals exaggerate their ability in leading better firm development[21]. Accordingly, overconfident executives behave

[21] Overconfidence is a generalized label used by much research discussing different managerial psychological upward biases. However, by restricting the notion, overconfidence is distinguished from or subdivided into other similar ideas, such as optimism (Malmendier & Tate, 2005), miscalibration (Ben-David et al., 2013; Hackbarth, 2009), overprecision/overextrapolation (Barrero, 2022). Therefore, following previous studies (Ben-David et al., 2013; Boulton & Campbell, 2016; Burks, Carpenter, Goette, & Rustichini, 2013; Camerer & Lovallo, 1999; Gervais, Heaton, & Odean, 2011; Hackbarth, 2008, 2009; Ronghong Huang, Tan, & Faff, 2016; Humphery-Jenner, Lisic, Nanda, & Silveri, 2016; Kaplan, Sørensen, & Zakolyukina, 2021; Malmendier & Tate, 2005, 2008; Otto, 2014; Pikulina, Renneboog, & Tobler, 2017) which differentiate overconfidence and other biases, this chapter only sticks to the narrow definition of overconfidence by theoretically considering overconfidence as the idea that addresses the overestimation of one's ability to improve future returns (whereas optimism refers to overestimation of future returns resulted from exogenous factors) (Malmendier & Tate, 2005)

differently in managing firms from rational executives. However, existing evidence points to mixed verdicts on whether such deviation rooted in overconfidence brings positive or negative influences. Hence, this study investigates whether firm performance benefits from CEO overconfidence by considering the relations between CEO overconfidence and firm stock liquidity, where stock liquidity is defined as the degree that firm stocks can be traded cheaply and swiftly (Chang, Chen, & Zolotoy, 2017) because stock liquidity reveals the value of firms (Cheung et al., 2015; Fang et al., 2009; Massa & Xu, 2013)[22].

To develop the theory framework, this chapter starts by describing how firm policies are linked to stock liquidity in an average firm managed by a rational CEO, then followed by discussing how do policies under overconfident CEOs differ from rational CEOs.

Firm policies can exert profound influences on stock liquidity of firms. Firm financials are one of the policies. Cash holdings typically suggest greater stock liquidity (W. Huang & Mazouz, 2018), and more borrowing (Andres et al., 2014) also increases stock liquidity, because these policies reflects healthy financial conditions. Others such as public offerings (Kothare, 1997), stock repurchases (De Cesari et al., 2011; Hillert, Maug, & Obernberger, 2016), green bonds (Tang & Zhang, 2020) make firms more liquid too, while these policies are more likely to work through improvements in corporate governance, e.g. reduction in information asymmetry. Related to financial policies, firm ownership or their funding sources, for example, private or state capital (Boubakri, Chen, El Ghoul, Guedhami, & Nash, 2020), individual or institutional ownership (Hameed, Kang, & Viswanathan, 2010; Heflin & Shaw, 2000), domestic or foreign capital (Levine & Schmukler, 2006), can affect stock liquidity, too. Because these factors may decide quality of corporate governance. These findings are supported by the evidence that better governance contributes to greater stock liquidity (Chung, Elder, & Kim, 2010). Besides, investment policies make impacts on stock liquidity. Investments that lead to uncertainty can eliminate the increase in stock liquidity made by cash holdings (Gopalan et al., 2012). In short, firm stock liquidity increases because the firm policies make investors positive expectations about firms.

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and underestimation of risks (e.g. volatility of future cash flows) (Ben-David et al., 2013); and empirically adopting option-based measures developed by Malmendier and Tate (2005).

[22] By utilizing the decimalization in the U.S. market, Fang et al. (2009) and Cheung et al. (2015) show stock liquidity is positively related to firm value. Fang et al. (2009) find that the feedback effects of informative stock prices and performance-based executive pay drive the relationship, while Cheung et al. (2015) demonstrate that in the context of REITs, stock liquidity improves firm value through feedback effects of informative stock prices. Massa and Xu (2013) conclude that stock liquidity is transferable, the liquidity of acquirers enhances when they take over a liquid target, thus acquirers are willing to pay a premium for liquid targets.

In an average firm with a rational CEO, a decrease in uncertainty[23] drives the increase in stock liquidity. Hence, policies that reduce such uncertainty are positively related to stock liquidity. For instance, excess cash holdings avoid insufficient liquidities and underinvestment, such positive firms' prospects attract external investors and increase trading activities on these firm stocks (W. Huang & Mazouz, 2018). Likewise, Gopalan et al. (2012) document that liquid assets increase stock liquidity by lowering uncertainty over asset-in-place. However, it does not hold if the liquid assets are likely to fund investments that are illiquid and uncertain. Besides, increased external financing can also reduce uncertainty and increase stock liquidity. For example, a higher expected debt ratio implies greater firm profitability (Andres et al., 2014); large public offerings introduce decentralized ownership structure that tolerates informed trading and allows external monitoring (Kothare, 1997); open market repurchase and resell of firm own stocks resist adverse impact from trading of market makers (De Cesari et al., 2011).

In a firm managed by an overconfident CEO who overestimates ability and underestimates risks, firm policies may be in the direction that either increases or decreases stock liquidity in rational firms. On the one hand, as overconfident CEOs overestimate their abilities, they believe they will improve the firm performance, therefore their firms are undervalued. Undervaluation increases the costs of external financing, which creates the motive for overconfident CEOs to build large cash reserves than rational CEOs (Y.-R. Chen et al., 2020; Malmendier, Tate, & Yan, 2011). However, relative to rational CEOs, overconfident CEOs raise more external funds when they do seek external financing. They borrow more (short-term) debt because they believe they can pay off the debt promptly (Ben-David et al., 2013; Y.-R. Chen et al., 2020; Hackbarth, 2008, 2009; Malmendier et al., 2011; Sen & Tumarkin, 2015). They issue more equity (Y.-R. Chen et al., 2020) and launch more SEOs when they perceive IPO under-pricing and expect market revaluation (Boulton & Campbell, 2016)[24]. Overconfident CEOs also retain more income to build cash reserves rather than paying out (Deshmukh, Goel, & Howe, 2013), prioritizing share repurchases (Banerjee, Humphery-Jenner, & Nanda, 2018). Therefore, CEO overconfidence should increase stock liquidity through *reinforced rational* financial arrangements. On the other hand, overconfidence also comes with an innate risk-taking preference. When risk-aversion leads to underinvestment

[23] According to Friberg and Seiler (2017), uncertainty contains risk, a predictable part, and ambiguity, an unpredictable part, this chapter aligns this idea and follows Gopalan et al. (2012), using uncertainty as a general term that may include all negative factors.

[24] Equity issuance deceases in increase of CEO overconfidence (Malmendier et al., 2011; Sen & Tumarkin, 2015).

even with private information, overconfidence counteracts risk-aversion to act in best-interest of shareholders by making more investments (Gervais et al., 2011), because overconfident CEOs underestimate risks, they see projects that are risky for rational CEOs have low risks. Overconfident CEOs thus invest aggressively, especially in acquisitions (Ferris et al., 2013; Malmendier & Tate, 2008; Sen & Tumarkin, 2015) and R&D projects (Hirshleifer, Low, & Teoh, 2012). Therefore, following a *rational* framework, CEO overconfidence triggers a high probability of converting liquid cash into illiquid investments that will make firms illiquid too.

However, firm policies made by overconfident CEOs often exert opposite effects to those of rational CEOs. Bold investment policies by overconfident increase firm value by alleviating underinvestment, which is caused by the risk-aversion of rational CEOs (Goel & Thakor, 2008), accordingly cash value in firms with overconfident CEOs becomes higher (Aktas et al., 2019; Y.-R. Chen et al., 2020). Accordingly, CEO overconfidence should increase through investments that decrease uncertainty. Conversely, firms suffer from wasteful spending provoked by large cash balances, such as overinvestment (Heaton, 2002; Malmendier & Tate, 2005; Sen & Tumarkin, 2015), pursuing diversified acquisition targets that cause a strong negative reaction from the market (Ferris et al., 2013; Malmendier & Tate, 2008). Extravagant spending eventually exhausts cash holdings (Deshmukh et al., 2021), which are too low to fund growth opportunities (Malmendier & Tate, 2005), and cash holdings becomes less valuable (Aktas et al., 2019). Therefore, CEO overconfidence should decrease stock liquidity through their financial plans that add uncertainty. Moreover, considering the likelihood of transferring liquid assets into illiquid assets determines the positive relationship between asset liquidity and stock liquidity (Gopalan et al., 2012), and overconfident CEOs deeply rely on internal liquidities (Ferris et al., 2013; Kaplan et al., 2021; Malmendier & Tate, 2005, 2008), investments of overconfident CEOs should dominate financial factors of overconfident CEOs to affect stock liquidity.

Covering the period from 1999 to 2019 with 1529 firms and 23,325 firm years, the main question examines whether CEO overconfidence is positively or negatively related to stock liquidity in the U.S. market. Following Malmendier and Tate (2005), CEO overconfidence is measured by CEO option holdings. Overconfident CEOs who believe in their ability in growing their firms will overestimate the returns and hold more options. This chapter considers two stock liquidity proxies, the *LM12* (W. Huang & Mazouz, 2018) trading discontinuity that measures turnover-adjusted zero trading days of individual firm stocks, and alternatively, the *Amihud* (Amihud, 2002) price impact index that measures the changes in firm stock price per dollar of trading. Both proxies reflect stock illiquidity.

The empirical tests yield two main results. First, on average, CEO overconfidence significantly increases firm stock liquidity. The proxy of CEO overconfidence is negatively related to both stock illiquidity measures, overconfident CEOs reduce trading discontinuity by 1.5 days and *Amihud* stock illiquidity ratio by 0.02. This stresses the positive influence brought by CEO overconfidence, which potentially accounts for the reasons why overconfident CEOs are preferred in the selection process (Goel & Thakor, 2008). Second, investments made by overconfident CEO significantly increase stock liquidity, but not for rational CEOs, consistent with Goel and Thakor (2008) who find overconfident CEOs increase firm value and Gopalan et al. (2012) who decides the conversion of liquid assets negatively affect stock liquidity.

There is also a series of robustness tests. First, the effect of other senior executives such as chief financial officers (CFOs) is considered. Overconfidence does not exclusively exist among CEOs but is widely found in other individuals (Banerjee, Humphery-Jenner, Nanda, & Tham, 2018; Barrero, 2022; Ben-David et al., 2013; Graham, Harvey, & Puri, 2013), these executives likely produce the same results as CEOs. However, no evidence supports CFO overconfidence increases stock liquidity. It may either be because CFOs only take supplementary roles relative to CEOs, or overconfident CFOs do not exhibit better professional ability.

Second, the age of CEOs can be relevant. Younger CEOs have longer career horizons, they would more carefully consider the firm policies to avoid negative influences (Jain, Jiang, & Mekhaimer, 2016). However, investment in acquisitions is associated with permanent pay increases, and the longer career horizon of younger CEOs means they can benefit from this increase earlier and longer if they are motivated to take more acquisitions (Yim, 2013). The conclusions can be biased if the age of CEOs affects how they invest. Therefore, the sample is split into firms that have younger and older CEOs and repeat the main tests. The results indicate that the findings are robust to controlling CEO age, CEO overconfidence and its interaction with investments in both groups are significantly negatively related to stock illiquidity.

Third, the effect of corporate governance is considered. To reduce the negative effects of CEO overconfidence, such as overinvestment, firms may discipline overconfident CEOs by threats of replacing them (Campbell, 2014; Campbell et al., 2011; Goel & Thakor, 2008), or by intervening their decisions (Banerjee, Humphery-Jenner, & Nanda, 2015; Goel & Thakor, 2008; Kolasinski & Li, 2013). The conclusions may be invalid if it is a positive relationship between corporate governance and stock liquidity (Chung et al., 2010; Jain et al., 2016). Firms are divided into good and poor governance groups by E-index of Bebchuk, Cohen,

and Ferrell (2008), the tests show that corporate governance does not affect the results.

Next, two potential endogeneity problems of the CEO overconfidence measure are stressed. First, inside information. As the overconfidence measure *Holder67* is based on CEO option holdings, rational CEOs can be incorrectly identified as overconfident CEOs if they hold large options out of other reasons rather than overconfidence, such as private information singling increases in returns. To mitigate the concern, firms are classified into groups whether CEOs hold inside information, where inside information is proxied by observing whether the CEOs gain or lose interest in their holdings by following Malmendier and Tate (2005). The conclusions hold for CEOs either win or lose profits from their option holdings. Second, endogenously matching. Endogenously matching indicates the match between companies and CEOs is not random, firms may intentionally choose overconfident CEOs due to unobservable factors (Y.-R. Chen et al., 2020; Deshmukh et al., 2021; Malmendier & Tate, 2005). To deal with the problem, this chapter takes three steps. Primarily, this chapter control firm and year fixed effects alongside all main tests, and the results remain significant. Next, controlling of CEO tenures. According to previous studies (Aktas et al., 2019; Hirshleifer et al., 2012), the effect of endogenous matching weakens over time, and a newly appointed CEO is more likely to be endogenously determined. The sample is restricted by excluding CEOs who have a tenure of less than one, three, or five years respectively. Tests by subgroups of the sample show that the conclusions remain valid. Finally, instrumenting the overconfidence measures through the 2SLS approach. The instrument considered is the *incidence*, which is defined as the chance that an overconfident individual will be appointed as CEO among all the candidates during the same period by following Deshmukh et al. (2021). Candidates can only affect stock liquidity when they become CEOs, not the possibility they will be appointed to be CEOs. Consistent with Deshmukh et al. (2021), the first stage results show this chance is positively related to CEO overconfidence. And the instrumented overconfidence proxy is negatively related to stock illiquidity, which indicates the conclusions from the main tests remain unchanged.

The contribution of this study is twofold. First, this chapter complements the overconfidence literature on firm performance by showing that CEO overconfidence exerts positive influences on stock liquidity, but CFOs do not. Prior studies focusing on distortion in firm policies and the degree of CEO overconfidence derive both positive and negative conclusions (Campbell, 2014; Campbell et al., 2011; Ferris et al., 2013; Goel & Thakor, 2008; Heaton, 2002; Malmendier & Tate, 2005, 2008). This chapter adds to the studies that at the mean level CEO overconfidence increases stock liquidity, which signals higher firm value; and their abnormal high-volume investments are the key drivers. Second, this chapter

provides a different angle to the literature on stock liquidity by addressing CEO overconfidence reversing the effects of rational policies. Prior studies have explained that rational firm policies move stock liquidity because of fluctuation in uncertainty (Andres et al., 2014; De Cesari et al., 2011; Gopalan et al., 2012; W. Huang & Mazouz, 2018; Kothare, 1997). Overconfident policies follow the same principle that increases stock liquidity by reducing uncertainty. However, overconfident CEOs increase (decrease) stock liquidity through policies that would decrease (increase) stock liquidity in firms with rational CEOs. In other words, the same policy executed by overconfident and rational CEOs may produce opposite results.

The remainder of this chapter arranges as follows. Section 3.3 provides the literature review. Section 3.4 describes the empirical strategy, including the measure of overconfidence and stock liquidity, and model specification. Section 3.5 and 3.6 provide empirical results and robustness tests. And section 3.7 concludes the study.

3.3 Literature Review and Hypotheses Development

3.3.1 CEO Overconfidence and Firm Financial Policies

Overconfidence explicates a series of behavioural finance problems. Burks et al. (2013) first uncover the mechanism behind overconfidence. Revealed by both theoretical and empirical evidence, overconfidence emerges from the idea that managers intentionally emphasize and express their positive beliefs to outsiders, whereas aversion to negative feedback from the market counters overconfidence. Additionally, they show overconfident managers actively update their beliefs about ability by looking for new information.

Led by upward bias, overconfident managers distort firm financial policies from rational managers. Empirically, Malmendier et al. (2011) find overconfident CEOs follow the standard pecking order of financing. Considering overconfident CEOs insist their firms are undervalued, they avoid costly external financing and rely more on internal financing. This belief in undervaluation also guides them to issue more debt than equity, especially when they are in financing deficiency, which subsequently makes for high leverage. Moreover, they show other characteristics that affect firm financing. CEOs who experience recession and serve in the military prefer internal and external financing respectively, because recessions expose the unreliability of external financing, while military life encourages risk-taking.

Similarly, Y.-R. Chen et al. (2020) discover that overconfident CEOs increase both levels of

cash holdings and cash value, and this effect increases with the level of overconfidence, especially in R&D-intensive industries. This is because overconfident CEOs intentionally keep cash holdings large for both current and future investments, and the market considers cash-funded risky projects, which concentrate in R&D-intensive industries, made by overconfident CEOs to increase firm value. Further evidence from panel regressions confirms overconfident CEOs hold cash out of precautionary motive, instead of transaction or agency motive. Beyond cash, overconfident CEOs prefer debt to equity by following the pecking order, and they issue more debt and equity than rational CEOs, saving more from proceeds of equity issuance to replenish cash reserves from being too low.

However, Deshmukh et al. (2021) hold opposite views regarding optimism and cash holdings. Because optimistic CEOs consider the cost of external financing is currently high due to their perceived firm undervaluation by the market, they believe the financing cost will decrease once the market learns the outcomes. Therefore, overconfident CEOs rely heavily on internal liquidities to make investments and do not concern about future funding. Their model and numerical tests confirm optimistic CEOs hold less cash than rational CEOs, and overconfident CEOs do not save more cash when future growth opportunities are high or save more cash out of cash flows for later use, whereas rational CEOs do. Their model also suggests optimistic CEOs can also deploy more aggressive external financing policies than rational CEOs despite the perceived high costs. Instead, it depends on the trade-off between the intention to invest and the fear that shareholder wealth is transferred to new investors if firms are undervalued.

Therefore, overconfident CEOs may use more internal liquidities than external liquidities, but they do not use fewer external liquidities than rational CEOs.

Modelling managerial overconfidence that involves firm growth overestimation and risk underestimation, Hackbarth (2008) shows that the former results in more debt issuance since it makes managers believe equity is undervalued, but more equity for the latter, as misbeliefs in the volatility of future income convince managers that debt is undervalued. Both the bias in growth and risks leads to higher debt levels and shorter debt maturities, given they are confident in future repayment affordability. However, overconfident managers prioritize debt by following growth perception bias, once the two biases are incorporated. As debt serves as a monitoring tool that prevents wasteful spending by overconfident managers, only moderately overconfident managers choose appropriate debt levels and increase firm value by acting in shareholders' interest, and higher debt aligns moderately overconfident managers with debtholders by improving investment value and investing earlier.

Hackbarth (2009) describes bondholder-shareholder conflicts around financing and

investments, where large borrowing induces debt overhang, shareholders expect equity value-maximizing by delaying investments, and bondholders expect firm value increase from more investments. With the introduction of CEO overconfidence or optimism that creates overly positive views on future returns, firms not only choose higher debt levels but also invest earlier, which reconciles the bondholder-shareholder conflicts.

Focusing on SMEs, Dai, Ivanov, and Cole (2017) show that optimism benefits firms in access to external financing. Because optimistic entrepreneurs are regarded to be highly committed and productive, empirical proofs suggest that small firms with optimistic managers pay trade credit timely and are more likely to get loans approved, enjoying unsecured and low-interest rate debt, which suggests a positive attitude of creditors to lending out.

Likewise, by investigating start-ups, Landier and Thesmar (2008) theoretically and empirically prove that optimism is positively related to more short-term debt. Specifically, optimism leads individuals to start their businesses as they hold wrong estimations over outcomes, especially if they have strong educational backgrounds. This overestimation of firms' prospects induces optimistic CEOs to finance through short-term debt, which can be paid back if the business turns successful, conversely, short-term debt from the view of a rational lender controls risks if the optimistic CEO become excessively reckless.

Extending samples to large firms, Ronghong Huang et al. (2016) conclude the same that it is CEO overconfidence with overestimation of firms' prospects contributes to more short-term debt (due within three years) and the proportion of short-debt over total debt, not because of lenders' will on providing certain debt. Additionally, overconfident CEOs may proceed with aggressive debt plans with liquidity risks, which accounts for refinance or repayment problems.

Furthermore, Boulton and Campbell (2016) explain how overconfident CEOs deal with information asymmetry that affects IPO offers made by the market. They find overconfident CEOs attempt to reduce information asymmetry through SEOs after IPO. In other words, firms managed by overconfident CEOs are positively related to IPO under-pricing, overconfident CEOs endeavour to signal their belief that their firms are undervalued and expect the market to revalue in subsequent large and frequent SEOs. However, as their belief about undervaluation is incorrect due to the overestimation of firms' prospects, rational investors are indifferent to such signalling and make no changes to SEO offers. Further evidence confirms that firms with overconfident CEOs do not outperform their counterparts in a longer horizon.

Under joint effects of misperception of costly external financing and high return investment

return, Deshmukh et al. (2013) show overconfident CEOs build cash reserves by paying fewer dividends to fund investments. However, when firms have high growth opportunities, it is the intention of investing, instead of overconfidence, that drives dividend reduction, as all types of CEOs start to pay out less. Information asymmetry also reduces cash dividends because it makes external financing expensive, but CEO overconfidence is not a driver. Conversely, overconfident CEOs overestimate future cash flows based on current cash flows, creating a greater positive sensitivity of dividends to current cash flows. The market reacts positively to dividend increases in firms with overconfident CEOs, given it reduces uncertainty.

As indicated by Banerjee, Humphery-Jenner, and Nanda (2018), bias in expectation of firms' prospects leads overconfident CEOs to overvalue their firms and believe the market undervalues their firms. Consequently, overconfident CEOs initiate more stock repurchases and spend more on repurchases. It is more pronounced when there are declines in stock prices that aggravate the undervaluation perception, when CEOs are not disciplined and powerful enough to follow their own will. It is also more pronounced when there are more institutional investors, as institutional investors may reckon more repurchases can reduce wasteful spending on investments, and it is likely that repurchases facilitate their exit from the company at a higher rate than market offers. Overconfident CEOs also conduct more repurchases by spending less on dividends but keeping dividends at a reasonable level that will not send negative signals to the market, and less on capital expenditures, when they perceive the benefit of correcting undervaluation that exceeds investment returns. Furthermore, insufficient cash holdings decrease repurchase activities, while compared with rational CEOs, overconfident CEOs are less affected as they prioritize the correction of undervaluation. And eventually rational investors respond negatively to such irrational repurchases in either the short or long run.

Also, CEO overconfidence also affects firms by significantly increasing investments, especially in risky projects.

Malmendier and Tate (2008) discover that with beliefs in their ability to create value through acquisitions, CEO overconfidence is positively related to the number of acquisition deals. Owing to the perceived idea that their firms are undervalued, overconfident CEOs only participate in acquisitions when they have sufficient internal liquidity but forgo when external financing is required. This reliance on internal liquidity is even greater when their firms are truly undervalued. When the firms become overvalued, equity financing is desired by overconfident CEOs. However, overly pursuing diversified projects create negative value, especially in cash-rich firms. Hence, overconfident CEOs fail in their own beliefs of

increasing shareholder wealth. Besides, the strong negative relation between the firm abnormal returns and CEO overconfidence around the time of acquisitions further proves these projects are value-decreasing.

Hirshleifer et al. (2012) first demonstrate overconfident CEOs underestimate risks and pursue risky projects through inflated firm stock return volatility. Next, they show overconfident CEOs are more likely to increase R&D expenses and produce more patents and patent citations, but only in industries where innovation is highly valued to allow risk-taking by overconfident CEOs. Conversely, overconfident CEOs outperform peers at yielding patents and citations at a given level of R&D spending and making one patent cited more times. Regression results further indicate firm stock return volatility, patent and citation numbers increase monotonically with the degree of overconfidence, whereas it is moderately overconfident CEOs who spend the most on innovation. Likewise, the firm value increases when firms are managed by overconfident CEOs who capture growth opportunities, and firm value increases monotonically with the level of overconfidence, especially in R&D-intensive industries.

More evidence revealed explains that firm financial and investment plans are correlated, which is clearer in firms managed by overconfident CEOs.

Heaton (2002) models the relationship between managerial optimism, free cash flow and investments. They show optimistic managers overvalue their firms and projects, overvaluation of firms leads to heavy reliance on internal financing, and overvaluation of projects stirs willingness to invest. Consequently, lack of internal liquidity discourages optimistic managers take both low- and high-quality projects, the former situation protects shareholders by deterring value-decreasing investments, whereas the latter scenario decreases shareholder wealth by rejecting projects that create value, additional cash flows then become valuable as they facilitate investments. Shareholders, therefore, prefer firms retaining cash when there are better investments, otherwise, they prefer the cash holdings to be paid out.

Malmendier and Tate (2005) empirically detect a strong positive relationship between cash flows and investments among firms with overconfident CEOs, especially in financially constrained firms (equity-dependent), because overconfident CEOs consider their firms have better prospects and are undervalued by the market, which makes CEOs avoid equity financing and rely on cash flows. Consequently, overconfident CEOs overinvest with adequate cash flows but underinvest when cash flows are insufficient. Personal background of CEOs except overconfidence also exerts influence on the investment-cash flow sensitivity, they find this sensitivity is more pronounced among those who receive technical education,

hold more positions in the firms, or were born in the Great Depression birth cohort, whereas CEOs who are educated in finance use less cash flows to invest.

By extending the geographical distribution of samples, Ferris et al. (2013) discover that CEO overconfidence widely exists around the world, but concentrating in countries where Christianity or individualism is prevalent. Panel regressions yield consistent results that overconfident CEOs around the world, even when the U.S. is excluded, contribute to more acquisitions, especially diversifying projects, and deeply rely on cash holdings.

Ben-David et al. (2013) look into miscalibration, which is an alternative version of overconfidence. Miscalibrated individuals believe they have access to accurate information that enables precise prediction of future returns. They first find CFOs are miscalibrated. In the experiment, CFOs provide their short- and long-term forecasts on market returns and confidence intervals. However, the forecasts are seriously deviated from reality, with the deviation lessening with increases in forecast time horizon, but increases during uncertain periods, as CFOs do not adjust their confidence intervals with uncertainty. Miscalibrated CFOs subsequently make incorrect predictions about their firms' returns and projects, resulting in higher investment levels and leverage.

Sen and Tumarkin (2015) introduce a new option-based measure of managerial optimism. Theoretically, they consider managers are optimistic when they retain a part of firm stocks after the options are exercised, because they overestimate firm returns, while rational managers diversify risks and sell all stocks. Replicated empirical tests according to the new measure confirm that optimism contributes to higher leverage, more debt in response to deficiency, and less equity, and when firms are financially unconstrained, optimistic managers increase acquisitions.

3.3.2 Impacts and Governance of CEO Overconfidence

The effect of CEO overconfidence on firm performance is not onefold, distortions in firm policies may produce either good or bad outcomes. As Graham (2022) explores the mismatch between academic research and practical outcomes through surveys with CFOs, they find in common assumptions, managers are rational and calibrated about expectations, whereas managers are biased in making forecasts, with firms accordingly either outperforming or underperforming anticipation. The response from CFOs also yields several other findings. First, short-term focus. Firms can only make reliable forecasts for up to two years with available information, which underlines short-term investments, payback methods for capital budgeting, current profitability and managing debt based on current cash flows.

Second, firm policies are conservative. Firms only make investments with excessive returns, preserve sufficient financial flexibility, and keep dividend increases flat in consideration of negative shocks. Third, decision-making is sticky. Traditional assumptions believe firms make decisions along with changes in markets, while firms consistently use the same methods in deciding the capital structure and investments. Fourth, decision-making is oversimplified. Firms are more likely to use payback methods, supplemented by the NPV rule in evaluating investments, instead of using complicated criteria.

To be more specific, the impacts of overconfidence are embodied in corporate expansion. An early study conducted by Camerer and Lovallo (1999) build a connection between overconfidence and market entry. Because overconfident individuals overestimate their ability, they believe they can outperform their peers. Both theoretical and numerical tests confirm overconfidence induces more new entries into the competition, especially when participants are knowing the outcomes depend on their ability. However, without knowledge about their true ability, the entries eventually yield negative incomes.

Banerjee, Humphery-Jenner, Nanda, et al. (2018) find that both overconfident CEOs and other overconfident senior executives provoke more securities class actions (SCAs). This is because they overestimate their firms' prospects, which leads them to make inaccurate disclosure, shareholders accordingly suffer losses caused by false information and launch lawsuits. However, improvements in corporate governance significantly reduce this negative effect. Firms that are affected by the passage of SOX, which enhances monitoring and CEO obligations, experience fewer SCAs. Being subject to SCAs also weakens the level of CEO overconfidence and lowers the willingness of firms to hire other overconfident CEOs.

Together with empirical regressions, the equilibrium of Barrero (2022) confirms that firm managers are not optimistic as they do not overestimate sales growth, whereas managers are overprecise, which means managers predict smooth growth, and overextrapolate, because they become either overly positive or negative about future based on current performance. The combination of overprecision and overextrapolation leads managers to overreact to shocks by wasting liquidities on human resources plans, and eventually make firm value up to 6.8% lower than those managed by rational managers.

Conversely, some others present the positivity of CEO overconfidence in firm performance, for instance, executive leadership with strong beliefs in firms' prospects drives stakeholders to be committed to the firm. Phua, Tham, and Wei (2018) accordingly find overconfident CEOs with such beliefs increase the number of their suppliers, especially suppliers from industries that rely on such leadership to make tailored products. The positive relation between CEO overconfidence and supplier R&D expenses for a long-lasting cooperative

relationship. Besides, employees are less likely to resign and are requiring more firm stocks in remuneration packages.

Consistent with studies showing the bright and dark sides of CEO overconfidence, the value of cash holdings in firms with overconfident CEOs also changes under different circumstances. Aktas et al. (2019) reckon the value of cash holdings depends on growth opportunities and availability. They first estimate the value of firm cash holdings is generally higher when overconfident CEOs are in charge, a dollar of cash is worth approximately 0.28 more because overconfident CEOs rely on internal liquidities, additional cash holdings relieve underinvestment problems associated with insufficient liquidities. Hence, the positive effect of CEO overconfidence on cash holdings is pronounced in firms that require additional liquidities, such as firms with a cash-raising regime, and growth firms that are financially constrained. In contrast, CEO overconfidence can also decrease cash value due to the waste of resources related to overinvestment.

Recent studies consider the degree of overconfidence or the real ability of overconfident CEOs to be important to explain the variation in firm value.

Likewise, Campbell et al. (2011) find the turnover rate of optimistic CEOs is also a concave function of optimism level. Their theoretical model deduces that optimism overcomes risk aversion by mitigating the reluctance of managers to invest, the more optimistic the more investments are made. However, firm value does not increase monotonically with optimism but exhibits concavity. Hence, there exists an optimal optimism level that maximizes firm value by choosing the first-best investment level, which aligns the interests of managers and shareholders, and both high and low-optimistic CEOs who fail to create value for firms are dismissed. This effect is more pronounced in firms that are well governed, as the boards also act in the interest of shareholders, they adjust the appointment of CEOs swiftly after the performance is observed. For comparison, they show optimism makes risk-neutral CEOs increase investments more rapidly, and firm value decreases monotonically quickly.

By focusing on both students and professionals, Pikulina et al. (2017) investigate the relationship between overconfidence and investments through experiments, in which participants are asked to estimate their own knowledge and test actual financial knowledge, then make investments. After getting participants' subjective estimation of their financial knowledge and objective evaluation of actual knowledge, the authors measure overconfidence as overestimation in one's ability compared with actual ability or overestimation in one's ability compared with peers; results suggest overconfidence is pervasive among participants. Further evidence from their subsequent investments indicates that value creation varies with the level of overconfidence; only moderate overconfidence is

value-maximizing. Moreover, they find overconfidence continues to increase investments when risk-aversion increases investments in the opposite direction.

Kaplan et al. (2021) focus on one of the widely used option-based overconfidence measures *Longholder*. Linear regressions indicate that overconfident CEOs underperform regarding a series of personal traits, such as they are less decisive and less committed. Factor analysis further reveals that overconfident CEOs are low-skilled, and both overconfident and low-skilled CEOs significantly account for investment-cash flow sensitivity.

However, except for direct effects on firm value, one benefit of overconfidence is that firms may save on human capital costs through executive compensation packages.

Croci and Petmezas (2015) first prove acquisitions are risky by recording increased stock return volatility around acquisitions; using the sensitivity of CEO wealth to stock return volatility to proxy risk-taking incentives, subsequently they detect a positive relation between risk-taking incentives and acquisition levels. However, they show this positive effect only holds in firms with rational CEOs, because the incentives overcome risk-aversion, whereas overconfident CEOs are risk-tolerant, such compensation is unrelated to them. Additionally, shareholder wealth grows as risk-taking incentives improve post-acquisition stock returns of acquirers, regardless of public or private targets.

The model of Gervais et al. (2011) reveals that risk-averse managers are indifferent to private information they have, so they underinvest and fail to gain benefits from private information, while with increases in overconfidence of risk-averse managers, they make the most use of this information to increase firm value. Firms then trade off the benefits of risk-taking incentives and the costs of excessive overconfidence by adjusting the level of performance-based pay based on the level of overconfidence. Similarly, firms offer less performance-based compensation and more safe pay to attract less-overconfident managers to work for them, managers are subsequently motivated to invest and create value for firms, which in turn benefit themselves. Conversely, highly overconfident managers are attracted to and motivated more by performance-based compensation, which they may suffer from as extreme overconfidence decreases firm value and generates low pay. Managers and firms thus match each other based on the level of overconfidence and firm characteristics, less-overconfident managers work at safe value firms and highly overconfident managers at risky growth firms. Compensation appears to motivate overconfident managers to learn more information about new projects because they overvalue the usefulness of such information.

Similarly, Graham et al. (2013) investigate psychological traits, such as optimism, risk-aversion and patience, across different countries through surveys. Demographical evidence shows CEOs are more optimistic than CFOs and are more optimistic and risk-tolerant than

ordinary people. Being in the U.S. also leads to greater optimism among senior executives. Empirical tests reflect that low-risk aversion causes more acquisitions, CEO optimism that triggers overestimation of future cash flows and debt-paying ability results in more short-term debt. These CEO traits also match firm characteristics. For example, a growth firm is more likely to hire a younger CEO who is overconfident and risk tolerant. Risk-tolerant CEOs also receive more performance-based compensation and are attracted to firms that provide such packages, whereas risk aversion is compensated by higher general pay.

Otto (2014) illustrates that optimistic CEOs receive lower incentive compensation, such as option grants, and lower total pays. Since optimistic CEOs overestimate firms' prospects, they overvalue the performance-based compensation they will receive, and the same amount of compensation become more valuable to optimistic CEOs; in other words, the same value of compensation means optimistic CEOs receive less actual compensation than rational CEOs. Consequently, optimistic CEOs also receive lower total pay because of objective valuation. Although optimistic CEOs also receive lower bonuses, the relation is mainly driven by bonus specified *ex-ante*, not the performance of optimistic CEOs *ex-post*.

Humphery-Jenner et al. (2016) indicate that overconfident CEOs overestimate firms' prospects, and thus overvalue performance-based compensation, which is less costly from a rational view of firms. Consequently, firms take advantage of this mis-valuation from overconfident CEOs and other senior executives and pay them more performance-based compensation. This effect is more pronounced in risky firms that offer more performance-based pay, or when the bargaining power of overconfident CEOs increases, firms must increase total pay to attract CEOs, and firms pay performance-based compensation that is overvalued by overconfident CEOs. Using the passage of SOX and FAS 123R, the authors confirm that performance-based pay of overconfident CEOs is a way of exploitation of mis-valuation. Because as an alternative to monitoring, compensation-based pay barely decreases with the emergence of SOX that increases monitoring, and with reporting of the fair value of performance-based compensation asked by FAS 123R, firms must compensate overconfident CEOs more in cash or stock, since shrinking in value of remuneration is larger for them due to prior overvaluation.

Considering the benefits and costs of CEO overconfidence, firms actively discipline CEOs, by either changing firm structure or changing the CEOs directly.

Goel and Thakor (2008) build a model that features a two-period intra-firm CEO selection process. In the first period of the model, some managers are motivated by the promotion competition, and they exhibit risk-taking behaviour, subsequently these managers succeed the CEO positions in the second period. Thus, overconfident managers who are more risk-

tolerant easily to be chosen as next CEOs. Under the optimal compensation contract that trades off risk-taking incentives and costs of imposing risks on risk-averse CEOs, rational and risk-averse CEOs underinvest and reduce firm value even if they have private information, while overconfidence encourages risk-averse CEOs to fully exploit the private information and invest. Hence, overconfidence and low risk-aversion co-exist and are distinguished from each other, firm value is a concave function of overconfidence but a linear function of risk-aversion, and firms dismiss both low-ability and highly/low-overconfident CEOs. Overconfident CEOs also overlook information acquisition due to beliefs in the precision of existing information, which leads to misjudging investment quality. Accordingly, the evaluation of CEOs becomes difficult if the CEOs are both moderately overconfident to increase firm value and underinvest in information to decrease firm value. Evidence suggests if there are penalties regarding information disclosure introduced by SOX, firms avoid the appointment of overconfident CEOs *ex-ante*, as overconfident CEOs underinvest in information precision.

Campbell (2014) finds firms recruit new CEOs based on previous experience through logistic regressions. Specifically, boards continue to hire CEOs with the same level of optimism after the departure of predecessors, for example, firms previously hire CEOs with moderate (low/high) optimism may still wish to hire such CEOs. However, the probability of hiring new CEOs with the same level is higher for firms with moderately optimistic CEOs, but the probability is lower for low or highly optimistic CEOs. Because firm value increases in concave optimism, moderate optimism maximizes firm value, and firms benefit from this success and repeat their choices, whereas very low or high optimism leads to lower firm value and incurs higher turnover. However, some firms with low and highly optimistic CEOs do not act instantly due to the domination of prior beliefs that low and high optimism is beneficial, although they have learned the negative from low and high optimism.

The through difference-in-difference approach features the passage of SOX and changes in listing rules as natural experiments[25], Banerjee et al. (2015) find improvements in board independence significantly reduce the deviation in overconfident behaviour and enhance firm performance because of better governance, disclosure, and monitoring. Overconfident CEOs become less aggressive in increasing spending – capital expenditures, assets, and administration fees all show negative growth. This effect is more significant for firms having more changes in their board to meet the new rules. Moreover, overconfident CEOs spend less cash flow on capital expenditures. Following these changes, both firm idiosyncratic and

[25] The Sarbanes-Oxley Act requires a fully independent audit committee, and more independent directors (Banerjee et al., 2015).

systematic risks decrease, the value of firms, their capital expenditures, and innovations rise, long-term returns of acquisitions grow, and less spending also encourages more cash dividend.

Overconfident CEOs may also be self-disciplined to reduce adverse effects. Kolasinski and Li (2013) establish a new measure of overconfidence by identifying CEOs who buy their own firm stocks and experience loss within the next 6 months of purchasing. Based on the measure, they find that overconfident CEOs significantly increase (diversified) acquisitions and decrease firm value through these projects. However, (diversified) acquisitions decline when there is an independent board with an appropriate number of directors (4-12 persons) because it provides effective monitoring. Overconfident CEOs are less acquisitive after experiencing loss in personal investments, which suggests the level of overconfidence weakens in experiencing bad outcomes.

3.3.3 Determinants of Stock Liquidity

Stock liquidity is affected deeply by firm activities, for instance, the financial policies of companies. Excess cash can benefits firms by avoiding cash shortfalls but can also damage firms by incurring agency costs. W. Huang and Mazouz (2018) show it appears external traders are attracted to the benefits of excess cash holdings, more trading diminishes trading discontinuity and liquidity risks (liquidity beta), thus excess cash holdings ameliorate stock liquidity. Reduction in trading discontinuity subsequently lowers the liquidity premium and the cost of capital, especially for financially constrained or growth firms. In addition, excess cash holdings increase firm value for illiquid firms.

Likewise, firm assets other than cash can also increase stock liquidity. Gopalan et al. (2012) show that assets with the same balance sheet value do not necessarily have equal liquidity value. Precisely, asset liquidity is positively related to stock liquidity, as liquid assets, which can include cash and non-cash current assets, are found to reduce uncertainty over firm assets. Hence, this positive relation is more pronounced for financially constrained and low-growth firms, in which liquid assets are less likely to convert liquid assets into illiquid assets that increase uncertainty. Liquid assets also generate greater value for illiquid firms because improved stock liquidity increases firm value by lowering borrowing costs and managerial incentive costs.

Equity liquidity reflects expectations from investors on information asymmetry. Because managers who hold inside information create disadvantages for investors and expose them to greater risks of loss, investors cut trading or enlarge bid-ask spreads thereafter, and firms

become less liquid. Focusing on American firms and measuring information asymmetry by equity liquidity, Andres et al. (2014) first show information asymmetry increases firm leverage. Firms also have leverage targets and actively adjust towards the targets when they are below the targets. In turn, they probe a negative relation between the expected adjustment of current leverage and information asymmetry from the investors' perspective, because the changes send positive signals to the outside about firm profitability.

Focusing on a special type of bond, the green bond, which supports environmental development, Tang and Zhang (2020) indicate firms that issue green bonds receive higher stock price offers and higher abnormal returns, especially for debut issuance. More evidence demonstrates that the increase is a result of an increasing number of certain institutional shareholders, e.g. pension funds. The green bond issuance also contributes to higher stock liquidity, as investors are attracted because of greater media exposure.

For equity financing, Kothare (1997) demonstrates that forms of offerings affect stock liquidity in the opposite direction. Specifically, rights offering is negatively related to stock liquidity, whereas public offerings increase liquidity, because different offerings also lead to different changes in firm ownership structure. Rights offering contributes to concentrated ownership, which hits informed trading and increases information asymmetry. Consistently, *ex-ante* stock prices of rights offering firms drop significantly.

Hillert et al. (2016) confirm the positive relationship between stock repurchase and stock liquidity. They consider firms as liquidity providers instead of liquidity demanders, especially when firms would like to take advantage of low transaction fees when liquidity is high; or to provide price support to their stocks by trading in small volume to reduce price impact, when investors are selling or when market volatility is high, and return is low. And they do not find evidence that liquidity reduction is caused by informed trading.

Particularly, in a market where trading rules are eased, firms benefit from open market repurchasing and reselling of their stocks, such behaviour of firms increases their stock liquidity and price stability. Open market repurchases allow firms to trade against existing market participants, intervening in the market to provide price support when they consider they are undervalued. The approval of shareholders on repurchase schemes also exert a positive and significant influence on stock liquidity and price stability (De Cesari et al., 2011).

As different types of equity issuance introduce different shareholders, different types of ownership also matter to firm stock liquidity. Heflin and Shaw (2000) find firms are less liquid when they have more block-holders, such as managers or institutions, who have access to private information via monitoring. Private information facilitates informed trading but

puts disadvantages on external investors. Investors react and trade against informed trading by incorporating a cost into the price, which translates into widening the bid-ask spreads, and reducing trading volume.

More recently, Chan, Cheng, and Hameed (2022) find the effects of institutional ownership on stock liquidity are not consistent. Different institutions serve different clients and purposes, the smaller the difference among the clients and purposes (a smaller heterogeneous investor base), the more illiquid the stock is, because they can reach a consensus on holding adjustments; on the contrary, a more heterogeneous investor base indicates high stock liquidity and low liquidity volatility, which is mandatory to reconcile different clients and needs.

Levine and Schmukler (2006) deem the liquidity of foreign shares of internationally cross-listed firms is negatively related to the domestic parts. First, this is because the liquidity of the proportion of internationalized shares is negatively related to other domestic firms. Internationalized firms are attracted to the international environment and shift their major stock trading into this market to counter the idiosyncratic risks in the home country, and thus the liquidity moves in opposite directions. Second, other domestic firms are positively related to the domestic parts of internationalized firms, as individual firms co-move with the trend of whole domestic market liquidity, which is referred to as the spill-over effects.

Also focusing on the international market, Ng, Wu, Yu, and Zhang (2015) show that foreign direct ownership (FDI) is negatively related to stock liquidity, while foreign portfolio ownership (FPI) is positively related to stock liquidity. This difference grows bigger in recession, FDI reduces stock illiquidity, and FPI reduces stock illiquidity. Because FDI has control rights over the firms, but FPI does not. Thus, FDI cuts trading, and FPI increases trading and investor base. And FDI is more likely to perform monitoring, through which FDI may bring different operation approaches that increase information asymmetry, investors avoid adverse selection by fewer transactions. Furthermore, when FDI increases the cost of capital, it also increases firm value through monitoring, whereas FPI affects firm value by exit.

Beyond private capital, Boubakri et al. (2020) suggest state funding also plays a part. The relation between state ownership and corporate stock liquidity is a convex function of the trade-off between the costs and benefits of state ownership, where the costs of state ownership concern non-pecuniary objectives, such as political goals, and benefits for firms are financially flexibility related. Therefore, stock liquidity benefits state ownership more in a recession when state ownership brings more financial flexibility to firms. Further analysis shows the optimal level of state ownership is 44%, and by balancing the costs and benefits,

the optimal level of state ownership is positively related to the degree of the political right and negatively to the political left, where political incentives are weaker.

Corporate governance can affect stock liquidity through information asymmetry. Better governance can be attributed to firms or external conditions.

Chung et al. (2010) demonstrate that improved firm-level corporate governance increases stock liquidity. Reinforced shareholder monitoring improves financial and operational transparency and lowers information asymmetry. It lowers the likelihood that managers manipulate information disclosed or extract private benefits. Disclosure of sufficient information reduces the heterogeneity of beliefs of investors because they are exposed to the same messages, and eventually, they make unanimous trading. Therefore, well-governed firms reduce informed trading, encourage investors to cut smaller bid-ask spreads, and the market quality develops. Better governance also lowers the required returns by investors, which translates into low costs financing for firms.

Exploiting the age difference between CEOs and their subordinate managers as the measure of governance, Jain et al. (2016) exhibit a positive relationship between governance and stock liquidity. They consider CEOs are more likely to focus on short-term benefits, while subordinate managers see long-term benefits, as subordinate managers will spend more time with the firm and thus are more careful about the firm, therefore, subordinate managers actively monitor CEOs by intervening in decision making and providing better information to the market to reduce information asymmetry. Further evidence shows this relation holds for firms with CEOs who are about to retire since they are more likely to focus on short-term benefits, or labour-intensive firms, in which subordinate managers are more dedicated to eliminating information asymmetry, or firms with experienced managers who are better at diminishing information asymmetry.

Given lower information asymmetry improves stock liquidity, firms are found to employ tactics of voluntary information disclosure conditional on external needs. For example, firms release messages about their prospects when analyst coverage shrinks leading to less information available to the public. Firms consequently benefit from greater stock liquidity through increased firm value and low-cost financing (Balakrishnan, Billings, Kelly, & Ljungqvist, 2014).

From a macroscopical view, Roy, Rao, and Zhu (2022) detect a positive relation between mandatory corporate social responsibility and stock liquidity, because greater corporate social responsibility reduces information asymmetry. This relation is pronounced for firms that suffer from information asymmetry, such as firms that do not belong to a business group, or with concentrated ownership, or geographically diversified firms, and this relation is also

pronounced for firms with heavy input in education and healthcare. Firms eventually benefit from higher valuation from their investment in corporate social responsibility.

Except for compulsory corporate social responsibility, other external regulations also monitor information asymmetry to improve liquidity. Qualitative discussion of Bhide (1993) indicates that while active monitoring, which creates information asymmetry by intervention in corporate governance and decreases stock liquidity, the U.S. market addresses the importance of stock liquidity by making regulations that facilitate governance of investors through exit than monitoring.

Agarwal, Mullally, Tang, and Yang (2015) suggest that institutional investors, such as mutual funds, have greater access to private information or uncommon public information, enforced disclosure of their positions can expose the information, which increases the transparency and liquidity of the disclosed stocks. Yet such disclosure requirement eliminates the advantages the investors have, which leads to a drop in their proceeds.

Compared with vague regulations that may leave more space for transactions, Cumming, Johan, and Li (2011) believe detailed rules in the stock exchange improve stock liquidity by controlling market manipulation, insider trading and broker-agency conflicts or other misbehaviour; market efficiency thereby improves thanks to reinforced investor confidence.

Odders-White and Ready (2005) show credit ratings are negatively related to adverse selection, which is proxied by stock liquidity. They extract a private part of the uncertainty that is only known to insiders, both credit ratings and adverse selection risks measure this part of the uncertainty. Firms with private negative shocks consequently have worse credit ratings and higher adverse selection costs simultaneously, which subsequently reveals a negative relationship between credit ratings and adverse selection.

However, based on the Norwegian market, Meling (2021) argues that too much transparency in the market reduces liquidity by discouraging trading incentives of informed participants. Consequently, anonymizing trader identities after the transactions are completed increases liquidity, which is portraited by spreads and trading volume. This anonymity allows the use of private information and order splits, thus attracting informed traders. Furthermore, early informed trading decreases adverse selection costs of market makers, who subsequently are willing to provide liquidity by charging fewer transaction costs and narrowing bid-ask spreads. Hence, both informed traders and market makers provide liquidity to the market.

Finally, Hameed et al. (2010) reflect an asymmetric effect of changes in market returns on stock liquidity. Specifically, because of higher costs and contraction of liquidity supply during a downward period, the extent to which negative market returns reduce liquidity is more than positive returns can increase stock liquidity.

3.3.4 Feedback from Stock Liquidity

Stock liquidity is important as it has a series of impacts on firm performance. Research has indicated that firm value is closely related to the liquidity of firm stocks.

Fang et al. (2009) document increases in firm value after the decimalization of stock trading, which increases firm stock liquidity. They advise that increased stock liquidity facilitates the exit of shareholders, such informed trading improves the information contained in stock prices, which in turn signals the management on following firm policies. And higher liquidity promotes performance-based compensation for managers. Both ways eventually discipline managers to improve firm performance and value.

Using firms from the Real Estate Investment Trust (REIT) industry, which mitigates the heterogeneity in settings and features the importance of corporate governance by obligated payouts and external ownership, Cheung et al. (2015) illustrate higher stock liquidity is related to higher firm value. Difference-in-difference tests based on the decimalization of trading indicate liquid firms become more valuable. Moreover, higher stock liquidity improves corporate governance, as liquid firms are attracted to institutional investors, especially those actively monitoring, or inclined to threaten to exit (who hold multi-ownership of REIT firms).

Additionally, increased threats of exit triggered by high liquidity effectively govern the management and decrease firm default risks (Brogaard, Li, & Xia, 2017), as they prove there exists a negative relation between stock liquidity and firm bankruptcy likelihood. By utilizing the decimalization event in the U.S. market, they show on average, one standard deviation increase in stock liquidity decreases this rate by nearly 27%. Importantly, stock liquidity contributes to information circulation among firms and investors. Investors are encouraged to acquire information and make informed bids, which provides feedback to managers and guides them for subsequent firm activities to reduce default risks.

Moreover, this liquidity is priced directly in a transaction. For example, Massa and Xu (2013) find firms are willing to pay a high premium to target firm in M&A transactions, as the liquidity of the target firms can be transferred to the acquirer firms, which makes the acquirer firms more liquid. Accordingly, firms that value liquidity tend to make higher offers, especially public firms with great institutional ownership, as some institutional investors demand high liquidity that facilitates exit to satisfy their client needs.

Edmans, Fang, and Zur (2013) understand stock liquidity is important to the corporate governance of block-holders. Specifically, they find greater stock liquidity increases hedge funds, which proxy block-holders. Hedge funds can impose governance through direct

interventions on management, or they can threaten to sell stocks and drive stock prices down, namely threat to exit, which affects manager wealth if they hold firm shares and are subsequently motivated to improve firm performance. Probit regressions indicate hedge funds prefer to exit instead of direct intervention. The gesture of threatening to exit wins positive market reactions and enhances firm performance, especially for firms that are more liquid and in which manager interests are closely linked to firm stock prices.

However, high stock liquidity can bring negative effects. Chatterjee, Hasan, John, and Yan (2021) reckon high stock liquidity can reduce firm value. The availability of low-cost financing in highly liquid firms allows empire-building through either stock or cash-traded acquisitions that are value-decreasing, whereas financial constraints and improved governance help to reduce the negative effects of empire-building by discouraging acquisitions.

Chang et al. (2017) show that stock liquidity is positively related to stock price crash risks. Because some investors are more sensitive to negative news and respond by selling them, which affects liquidity, while high liquidity comes with a high likelihood of bad earning news, managers choose to hide the news to avoid selling by investors. Yet the bad news piled up and ultimately cause a bigger volume of selling leading to a detrimental price impact.

Existing studies also show how stock liquidity shapes corporate investments. Roosenboom, Schlingemann, and Vasconcelos (2013) model acquisitions and deem acquirer returns are negatively related to stock liquidity, but only when the acquisition targets are privately owned. This is because higher stock liquidity encourages exits of shareholders, namely selling off their shares, but discourages monitoring. However, a public target is more likely to require monitoring when there are negative returns, which is in contrast to a private target. Stronger monitoring and higher agency costs intensify this negative relation more. Detrimental outcomes eventually trigger acquisition deal withdrawal and force CEO turnover.

Ee, Hasan, and Huang (2022) also find stock liquidity improves labour investment efficiency. When high liquidity increases the sensitivity of manager wealth to stock price, threats of exit urge managers to protect their wealth by boosting investment performance.

In general, high liquidity accelerates investments, conversely, stock illiquidity impedes corporate investments by increasing financing costs regardless of financial constraints. This allows firms to adjust investment policies by learning investor expectations through illiquidity premiums. Meanwhile, tight financial restrictions compel firms to improve the efficiency of the use of funds by increasing marginal productivity and adapting to labour-intensive production (Amihud & Levi, 2022).

In contrast, high stock liquidity is also found to reduce investments in innovation (Fang, Tian, & Tice, 2014). As a result of high liquidity, ease of entry or exit increases the probability of hostile takeovers and decreases active investing based on current performance, managers are thus inclined to focus on short-term outcomes rather than innovations that require long-term input and can be misvalued due to information asymmetry.

Payout policies also have implications on stock liquidity. Banerjee, Gatchev, and Spindt (2007) reckon liquid firms are less likely to pay dividends. The rationale is that compared with dividends, investors receive less by selling them, given stock transactions are charged at a cost, which is negatively related to stock liquidity.

Parallel to the findings, Brockman, Howe, and Mortal (2008) conceive that liquid firms benefit from repurchases from tax advantages over the costs of informed trading. Therefore, liquid firms have a strong preference for repurchases, these firms are more likely to initiate repurchase decisions or maintain their existing repurchase policies.

Furthermore, De Cesari, Espenlaub, Khurshed, and Simkovic (2012) advise that when firms repurchase to take advantage of undervaluation, high stock liquidity helps firms save costs by 0.25% of their capitalized equity or 0.54% their book assets on average owing to low transaction fees. The smaller price impact also accelerates repurchases.

The repurchase effects are pronounced when the ownership of informed investors, like managers or institutions, is smaller, because a large volume of informed trading mitigates undervaluation quickly. Improved liquidity reduces the likelihood of earnings management (Li & Xia, 2021).

3.3.5 Hypotheses Construction

In firms with *rational* CEOs, stock liquidity increases with a decrease in uncertainty. For example, although free cash problems are possible, excess cash decreases trading discontinuity (increases stock liquidity), because cash holdings avoid cash shortfalls and lower uncertainty (W. Huang & Mazouz, 2018). Likewise, Gopalan et al. (2012) document that liquid assets increase stock liquidity, given liquid assets reduce uncertainty over asset-in-place. Hence, financially constrained firms and low-growth firms that are less likely to convert liquid assets into investments that are illiquid exhibit a stronger asset-stock liquidity effect. Similarly, increased external financing reduces uncertainty by signalling greater firm profitability and reducing information asymmetry. Andres et al. (2014) find higher expected leverage ratio enhances stock liquidity. And public offerings increase stock liquidity by contributing to a dispersed firm ownership structure, as Kothare (1997) reckons such

ownership tolerates informed trading, and also reduces information asymmetry by allowing more external monitoring. Moreover, open market repurchasing and reselling of firm own stocks increase stock liquidity by trading against market makers (De Cesari et al., 2011).

In firms with *overconfident* CEOs, firm policies may be distorted. Two key features of overconfidence are that CEOs believe they are superior in improving firms' future returns and predicting risks, which generates two implications. First, with the belief that firms' prospects are getting better, overconfident CEOs consider the firms are currently being undervalued. CEOs act against this undervaluation by hoarding more cash, since undervaluation leads to expensive external financing (Y.-R. Chen et al., 2020; Malmendier et al., 2011), paying fewer dividends to replenish cash holdings (Deshmukh et al., 2013), and prioritizing share repurchases (Banerjee, Humphery-Jenner, & Nanda, 2018). However, overconfident CEOs are not necessarily self-contained despite the perceived high costs of external financing[26]. Compared with rational CEOs, overconfident CEOs with the belief in their firms' future borrows more, especially short-term debt, because of the confidence in timely repayment (Ben-David et al., 2013; Y.-R. Chen et al., 2020; Hackbarth, 2008, 2009; Malmendier et al., 2011; Sen & Tumarkin, 2015), more equity issuance (Y.-R. Chen et al., 2020), and more SEOs if they try to signal undervaluation to reverse IPO under-pricing, which fails later (Boulton & Campbell, 2016).

Second, overconfident CEOs underestimate risks, which encourages them to take on investment projects that are too risky for rational CEOs. One direct evidence is that overconfident CEOs significantly hold a larger proportion of highly risky assets, which may include derivatives like mortgage-backed securities, as a part of cash holdings (Duchin et al., 2017). When looking into real investments, rational CEOs require incentives to make risky investments like acquisitions, overconfident CEOs do not. Following the incentives, firm returns grow and shareholder wealth increases, as incentives encourage the risk-taking of rational CEOs (Croci & Petmezas, 2015). This risk-tolerance of overconfident CEOs induces them to maintain high investment levels, especially acquisitions (Ferris et al., 2013; Malmendier & Tate, 2008; Sen & Tumarkin, 2015) and innovations (Hirshleifer et al., 2012). Low-risk aversion encourages more acquisitions too (Graham et al., 2013). However, overconfidence does not equal low-risk aversion[27]. Risk-averse CEOs would invest safely

[26] Deshmukh et al. (2021) theoretically explain that overconfident CEOs pursue more external financing than rational CEOs, if their beliefs are dominated by the desire to make investments.

[27] Goel and Thakor (2008) find firm value is a positive linear function of low-risk aversion, but a concave function of CEO overconfidence. Campbell (2014) determines there exists a first-best level of overconfidence that perfectly aligns the interests of CEOs and shareholders, both very high and low overconfidence are

even if they hold private information, but overconfidence offset such conservatism by inducing CEOs to make the most use of private information to align interests with shareholders (Gervais et al., 2011).

Therefore, overconfident CEOs display traits that may either increase or decrease stock liquidity in the *rational* framework. Overconfident CEOs increase stock liquidity through aggressive financial plans, such as abnormally high cash holdings that lower uncertainty. Otherwise, they can decrease stock liquidity by a large chance of internally funding investments that add uncertainty, since they are highly dependent on internal liquidity (Ferris et al., 2013; Kaplan et al., 2021; Malmendier & Tate, 2005, 2008).

Conversely, overconfident CEOs can increase or decrease stock liquidity in the *overconfident* framework too, but in opposite directions. Specifically, investments made by overconfident CEOs increase firm value by eliminating underinvestment (Goel & Thakor, 2008). They also regard development sustainability by winning employee commitment and constructing strong business partner networks (Phua et al., 2018). These positive effects translate into a high value of cash holdings (Aktas et al., 2019; Y.-R. Chen et al., 2020) and lower uncertainty. However, adequate internal liquidities faciliate wasteful spending that creates uncertainty, such as overinvestment (Heaton, 2002; Malmendier & Tate, 2005; Sen & Tumarkin, 2015), immoderately bidding in acquisition deals and overly pursuing diversification of acquisition targets (Ferris et al., 2013; Malmendier & Tate, 2008), which are all value-decreasing. Accordingly, cash holdings are depleted in turn (Deshmukh et al., 2021), which results in underinvestment (Malmendier & Tate, 2005). Eventually, the value of cash holdings also decreases (Aktas et al., 2019). Additionally, overconfident CEOs receive lower cash pay and more performance-based compensation (Gervais et al., 2011; Humphery-Jenner et al., 2016; Otto, 2014), which not only saves human capital costs but also disciplines their aggressive behaviour to decrease uncertainty.

Hypothesis 1a CEO overconfidence increases stock liquidity.

Hypothesis 1b CEO overconfidence decreases stock liquidity.

Nonetheless, the effects of investments should dominate that of financial plans in CEO overconfidence affecting stock liquidity. There are two reasons. First, investment behaviour is key in CEO selection. The boards determine CEO succeeders by assessing the risk-taking

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detrimental.

activities of candidates in the form of investments, and overconfident CEOs who are innate risk-takers are more likely to be selected (Goel & Thakor, 2008). Aggressive investments by overconfident CEOs not only mitigate underinvestment problems caused by rational CEOs and maximizes shareholder wealth but increase bondholder wealth. Because rational CEOs hold priority on growing shareholder wealth by postponing investments when there is high debt, while overconfident CEOs do not put off investments while maintaining high debt, which makes the interest of shareholders and bondholders compatible, thus firm value increases rather than only equity value (Hackbarth, 2008, 2009). Although CEO overconfidence may be potentially detrimental, firms consider the benefits brought by overconfident CEOs through investments to outweigh the harms from other aspects. Otherwise, the boards are less likely to consider overconfident CEOs if they expect negative outcomes (Banerjee, Humphery-Jenner, Nanda, et al., 2018), or make personnel changes as soon as the outcomes are observed (Campbell, 2014; Campbell et al., 2011).

Second, financial plans serve as a supporting role to investments. Overconfident CEOs build large cash reserves (Y.-R. Chen et al., 2020; Deshmukh et al., 2021), issuing equity to replenish cash holdings (Y.-R. Chen et al., 2020), and they are highly likely to make investments by these internal liquidities (Ferris et al., 2013; Kaplan et al., 2021; Malmendier & Tate, 2005, 2008). The eventual value of cash holdings is also dependent on investments (Aktas et al., 2019). Since the positive relationship between asset liquidity and stock liquidity is subject to the possibility that the liquid assets will be converted into illiquid assets in average firms (Gopalan et al., 2012), the effects of investment activities should outweigh the effects of cash holdings in driving the CEO overconfidence–stock liquidity relationship too. Therefore, albeit too much cash holdings incur large costs, if investments made by overconfident CEOs are beneficial in the *overconfident* framework, a positive relation between investments and stock liquidity for firms with overconfident CEOs should be observed.

Hypothesis 2 CEO overconfidence-stock liquidity relation is driven by investments.

3.4 Empirical Strategy

3.4.1 Data and Samples

The data is from CRSP/Compustat merged dataset, which provides financial information, also stock information from CRSP, and Execucomp which provides CEO compensation

information[28] (more details added in footnote). This chapter covers all qualified active publicly traded firms in the U.S. market. The sample period ranges from 1999 to 2019.

3.4.2 Measures of CEO Overconfidence

Overconfidence is unobservable, previous literature has built various proxies including survey/experiment-based measures (Barrero, 2022; Ben-David et al., 2013; Graham et al., 2013; Pikulina et al., 2017) that involves interviews with large numbers of executives and assessment of self-evaluation of interviewees; corporate investment-based measures (Boulton & Campbell, 2016; Campbell et al., 2011) identify overconfident managers by finding whose firms with investment levels exceed 80% of peers; earnings forecast-based measures (Kaplan et al., 2021; Otto, 2014) spot overconfident CEOs as whose predicted EPS fail to meet realized EPS; press-based measures (Aktas et al., 2019; Banerjee et al., 2015; Banerjee, Humphery-Jenner, Nanda, et al., 2018; Boulton & Campbell, 2016; Deshmukh et al., 2013; Ferris et al., 2013; Hirshleifer et al., 2012; Humphery-Jenner et al., 2016; Malmendier & Tate, 2008; Malmendier et al., 2011) searches for overconfident managers by counting who appear more in media chapters with words/phrases signalling confidence, or use more words/phrases signalling confidence in SEC filing.

This chapter uses the option-based approach *Holder67* developed by Malmendier and Tate (2005). The measure is widely used in existing studies (Banerjee, Humphery-Jenner, Nanda, et al., 2018; Y.-R. Chen et al., 2020; Croci & Petmezas, 2015; Hirshleifer et al., 2012; Humphery-Jenner et al., 2016; Kaplan et al., 2021; Malmendier & Tate, 2008; Malmendier et al., 2011; Phua et al., 2018; Sen & Tumarkin, 2015). The intuition behind the option holdings is that although firm options may be held either forcibly in the vesting period or voluntarily, rational CEOs should diversify risks by exercising these options once they can, whereas overconfident CEOs may be volunteered to hold options more and longer as a result of perceived firms' prospects.

[28] Based on SEC filing DEF 14A, Execucomp provides information on executive personal details and their compensation, such as executive age, gender, titles, tenures, earnings, shares, and options granted. Execucomp is first utilized to construct the option-based measures of overconfidence of Malmendier and Tate (2005) by Campbell et al. (2011), and followed by subsequent overconfidence-related studies (Aktas et al., 2019; Banerjee et al., 2015; Banerjee, Humphery-Jenner, & Nanda, 2018; Banerjee, Humphery-Jenner, Nanda, et al., 2018; Campbell, 2014; Y.-R. Chen et al., 2020; Croci & Petmezas, 2015; Deshmukh et al., 2021; Duchin et al., 2017; Hirshleifer et al., 2012; Ronghong Huang et al., 2016; Humphery-Jenner et al., 2016; Kolasinski & Li, 2013; Malmendier et al., 2011; Otto, 2014; Phua et al., 2018; Sen & Tumarkin, 2015).

Holder67 is a binary variable that equals 1 when the CEO is overconfident, otherwise it is 0. To be considered as overconfident, the CEO must hold 67% or more of their firm options that are in-the-money at least twice (i.e. two yearly observations) during the sample period[29]. The CEO then is overconfident from the first time the CEO is observed to hold 67% of in-the-money options, put differently, *Holder67* becomes 1 from the first observation of holding 67% in-the-money options. And the overconfidence of the CEO remains consistent during the sample period unless the CEO is replaced.

The moneyness (holding of in-the-money options) is computed as the average realized value per option divided by the average exercise value per option[30]. The average realized value per option is the estimated value of unexercised exercisable options divided by the number of unexercised exercisable options (Execucomp item *OPT_UNEX_EXER_EST_VAL* divided by *OPT_UNEX_EXER_NUM*), and the average exercise value per option is the difference between firm stock prices at the fiscal year-end and average realizable value per option (Compustat item *prcc_f* minus Execucomp item *OPT_UNEX_EXER_EST_VAL / OPT_UNEX_ EXER_NUM*).

The adoption of *Holder67* has several reasons. First, the option-based approach is more frequently used among other measures, there are sufficient literature proves its reliability. Second, the data is accessible without demanding fieldwork. Third, option holdings as alternative investments are directly related to CEOs' wealth, yet firm investments may be linked to agency problems. Fourth, it also distinguishes overconfidence from optimism. Because overconfident CEOs overrate their ability to create high returns and must hold more options, whereas optimistic CEOs attribute positive outcomes to exogenous conditions and do not necessarily invest in their firms (Malmendier & Tate, 2005).

3.4.3 Measures of Stock Liquidity

The dependent variable is stock liquidity, there are two proxies used in the following tests. The first is *LM12*, which reflects trading discontinuity defined as turnover-adjusted zero trading days over the past 12 months, by following W. Huang and Mazouz (2018).

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[29] The cut-off of 67% is derived from the premise that Hall and Murphy (2002) suggest the early exercise behaviour of option holdings of risk-averse executives in their model based on the assumption of a constant relative risk-aversion parameter 3 (larger number indicates greater risk-aversion) and an initial option holding level worth 67% of the executive wealth (higher level indicates lower diversification).

[30] Some studies also consider the moneyness as a continuous overconfidence measure (Banerjee et al., 2015; Banerjee, Humphery-Jenner, Nanda, et al., 2018).

$$LM12_{i,t} = \left[Zeros_{i,t} + \frac{1/Turnover_{i,t}}{Deflator}\right] * \frac{252}{Trade_{i,t}}$$

Where *Zeros* is the number of trading days with zero trading volume in year *t*, *Turnover* is the sum of daily turnover, *Deflator* is set to be a fixed constant of 11,000 to keep the fraction positive but smaller than 1 (W. Huang & Mazouz, 2018), and *Trade* is the total number of trading days of stock *i* in year *t*. *LM12* measures the level of illiquidity, a higher value of *LM12* predicts an elevated level of trading discontinuity and thus low stock liquidity.

The reason for using it as the main proxy for stock liquidity is that *LM12* is straightforward and multi-dimensional. Qualitatively, the measure is based on the idea that stock trading proceeds when the transactions are profitable, with more potential loss, less trading, and less liquidity. Quantitively, it incorporates two stock liquidity measures *Zeros* (Boubakri et al., 2020; Roy et al., 2022) and 1/*Turnover* (Chan et al., 2022), which can be used independently but are regarded as onefold in purposes like bid-ask spread or *Amihud* index (W. Liu, 2006). Therefore, *LM12* mirrors stock liquidity in trading cost, speed, and quantity (W. Huang & Mazouz, 2018).

Yet the *Amihud* illiquidity measure is still adopted as a part of robustness tests. *Amihud* is chosen over bid-ask spread because the latter may be too small to be influential, especially in large transactions (W. Huang & Mazouz, 2018). Introduced by Amihud (2002), this measure reflects the price impact of transactions, namely the changes in stock price per dollar of trading and it is widely used and tested in existing research[31]. To avoid skewness, this study follows Gopalan et al. (2012) by using the annual average of the square root of the daily ratio of absolute stock return over trading volume, it is computed as:

$$Amihud_{i,t} = \frac{1}{N_{i,t}} \sum_{j=1}^{N_{i,t}} \sqrt{\left|r_{i,j}\right| / (P_{i,j} * Vol_{i,j})}$$

Where $N_{i,t}$ is the number of trading days available in year *t*, $|r_{i,t}|$ is the absolute return of stock *i* on day *j*, $P_{i,j}$ is the daily stock price and $Vol_{i,j}$ is the number of daily trading. Alike *LM12*,

[31] The *Amihud* ratio and its variants are employed in many kinds of literature this study refers to (Agarwal et al., 2015; Balakrishnan et al., 2014; Boubakri et al., 2020; Chan et al., 2022; De Cesari et al., 2012; Gopalan et al., 2012; Hillert et al., 2016; Levine & Schmukler, 2006; Ng et al., 2015; Roy et al., 2022; Tang & Zhang, 2020).

this proxy measures illiquidity, a higher value should indicate lower stock liquidity.

3.4.4 Model Specifications and Control Variables

To test the hypotheses constructed, the model specifies as follows:

$$Liquidity_{i,t}=\alpha+\beta_1 Overconfidence_{i,t}+\beta_2 X_{i,t}+fe_{i,t}+\varepsilon_{i,t} \quad (3\text{-}1)$$

Where $Liquidity_{i,t}$ is the stock liquidity proxy of firm i in year t (*LM12* and *Amihud*), $Overconfidence_{i,t}$ is the CEO overconfidence indicator (*Holder67*), $X_{i,t-1}$ represents a series of control variables, $fe_{i,t}$ and $\varepsilon_{i,t}$ are year/firm fixed effects and the error term, respectively. $Overconfidence_{i,t}$ is the variable of interest, because it is a dummy variable, β_1 reflects the additional impacts of overconfidence compared with average firms without overconfident CEOs.

To allow investigation on the effects of corporate investments, a proxy for corporate investments is added in equation (3-1):

$$Liquidity_{i,t}=\alpha+\beta_1 Overconfidence_{i,t}+\beta_2 Overconfidence_{i,t}\times RiskyInvestments_{i,t-1} +\beta_3 RiskyInvestments_{i,t-1}+\beta_4 X_{i,t}+fe_{i,t}+\varepsilon_{i,t} \quad (3\text{-}2)$$

Where $RiskyInvestments_{i,t-1}$ is lagged sum of a firm's acquisitions and R&D expenses, missing values are set to zero. Since Goel and Thakor (2008) indicate it is the risk-taking behaviour of overconfident CEOs attracted to firms, both acquisitions and innovation are considered to capture riskiness (Croci & Petmezas, 2015; Hirshleifer et al., 2012). Therefore, β_2 suggests the additional impacts of risky investments made by overconfident CEOs compared with average firms without overconfident CEOs.

Based on extant studies (Agarwal et al., 2015; Gopalan et al., 2012; W. Huang & Mazouz, 2018; Roy et al., 2022), the model controls following a firm's characteristics: firm's size (*Size*), natural logarithm of market capitalization (CRSP items *prc*shrout*); leverage (*Leverage*), the ratio to total debt to total assets; a dummy for dividend payers (*Dividend*), which equals one if Compustat item *dvc* is above zero; growth opportunity measured by book-to-market ratio (*B/M*), the ratio of book value of equity to market value of equity (Compustat item *ceq/prcc_f*csho*); firm performance measured by return on assets-in-place (*ROA*), the ratio of earnings before interest, taxes, depreciation and amortization to total

assets (Compustat item *ebitda/at*); and stock return volatility (*Volatility*), yearly standard deviation of firm daily stock return.

3.4.5 Endogeneity

Three potential endogeneity problems of the option-based overconfidence measure that may bias the results are identified.

First, corporate governance. To make sure the overconfidence measure is accurate, it is necessary to confirm that the option holding is entirely voluntary. However, if CEOs hold options only as a governance strategy, then they may be mistaken for overconfident CEOs. Campbell et al. (2011) argue that the boards or investors value the incentives from options and wish CEOs to hold more. Alternatively, according to Phua et al. (2018), CEOs may build their leadership by more option holdings that send positive beliefs. Consequently, if option holdings represent a management style instead of personality, the results can be biased. To mitigate this concern, this study follows Campbell et al. (2011) and control for corporate governance in additional tests by constructing the BCF index (Bebchuk et al., 2008). If the results are driven by corporate governance, then the overconfidence-stock liquidity effect is predicted to exist only in good governance firms.

Second, inside information. *Holder67* is based on the idea that the options are held because CEOs overestimate their ability to increase firm returns, in contrast, rational CEOs exercise their positions to diversify risks as soon as they can. However, if the option holdings of rational CEOs are because they hold private information that indicates increased future returns (Banerjee et al., 2015; Campbell, 2014; Campbell et al., 2011; Malmendier & Tate, 2005, 2008; Malmendier et al., 2011), or manipulate information disclosed to inflate equity value (Banerjee et al., 2015; Banerjee, Humphery-Jenner, Nanda, et al., 2018), these rational CEOs can be incorrectly classified as overconfident CEOs, therefore, the relations between CEO overconfidence can be driven by rational CEOs.

To minimize the concern, CEO samples are split into those who lose a fortune in option holdings and those who win by following Malmendier and Tate (2005). If CEOs are overconfident, they should make judgements solely on their biased views on returns and risks, which incurs a loss. Conversely, rational CEOs with inside information should benefit from holding more options and receiving positive returns. If it is inside information that drives the results, then the results should not hold in the group that suffers a loss in option holdings.

Second, endogenously matching. Another concern is whether CEO overconfidence is

exogenous. In other words, the match between overconfident CEOs and firms should be random. Firms adjust their appointment of overconfident CEOs based on their observable performance *ex-post* (Campbell, 2014). However, there can be omitted variables that lead to the endogenously matching of CEOs and firms (Y.-R. Chen et al., 2020; Croci & Petmezas, 2015; Deshmukh et al., 2021; Malmendier & Tate, 2005), which means the boards recognize and hire overconfident CEOs due to unobservable factors *ex-ante*[32].

To eliminate concerns over endogenous matching, three steps are taken. First, firm fixed effects and year fixed effects are considered along with all regressions to control omitted variables that may affect CEO selection and behaviour (Deshmukh et al., 2021; Malmendier & Tate, 2005; Malmendier et al., 2011; Sen & Tumarkin, 2015).

A second method to mitigate the effects of endogenous matching is to restrict samples by CEO tenures (Aktas et al., 2019; Hirshleifer et al., 2012), exclude CEOs who have a tenure of less than one, three, or five years respectively, as some studies argue that the effects of endogenous matching weaken by time, i.e. a newly appointed CEO is more likely to be endogenously determined (Aktas et al., 2019; Hirshleifer et al., 2012). Any missing appointment year is set as 1999 and leaving year as 2019, which are the start and end of the sample period.

Finally, applying of instrumental variable (IV) in the 2SLS strategy. Following Deshmukh et al. (2021), the likelihood of the overconfident CEO is hired as the instrument. According to Deshmukh et al. (2021), with more overconfident candidates, companies are less likely to choose rational CEOs regardless of their preference. Moreover, it is hard to build a causality between the likeliness of candidate CEOs being chosen and stock liquidity. The instrument is constructed as the proportion of overconfident CEOs over the total CEOs appointed in the same period. Deshmukh et al. (2021) do so by considering the same month in the same year, this chapter relaxes the condition by considering the same year only due to the availability of data. More details and discussions of endogeneity are presented below.

3.4.6 Descriptive Statistics

Table 3-1 demonstrates descriptive statistics of the sample for the period from January 1999 to December 2019, there were 1505 firms and 23,325 observations in total. Comparatively, the samples contain more overconfident CEOs. The proxy of CEO overconfidence *Holder67*

[32] If endogenously matching exists, we should know as the boards would have taken observable actions to balance the costs of hiring overconfident CEOs (Malmendier & Tate, 2005).

has a mean of 0.858 of *Holder67*, suggesting that around 85% of CEOs in the sample are overconfident, close to Graham et al. (2013) who show 80.2% of CEOs are overconfident[33]. *LM12* proxies the level of stock illiquidity by measuring trading continuity (W. Huang & Mazouz, 2018). The average of *LM12* is 4.3, suggesting that a mean firm has 4.3 turnover-adjusted zero-trading days[34], suggesting the sample firms are generally more liquid. The average *Amihud* is 0.0630, which is the percentage of amount changes in stock prices with every dollar of trading, close to the 0.05 of Massa and Xu (2013). The control variables *Size*, *Leverage*, *B/M* ratio, *ROA* and *Volatility* display firm characteristics, for example, the average size of sample firms is 14.77, and raw size equals 11.9 million (untabulated), smaller than the 1.6 billion of Gopalan et al. (2012), but shows some similarity, such as an average cash ratio (*ROA*) of 0.145 (0.118) in this chapter to 0.142 (0.115) in Gopalan et al. (2012).

Table 3-2 compares the characteristics of firms with and without overconfident CEOs. Column 7 shows that the differences (column 4 minus column 1) are highly significant, especially the stock illiquidity proxies on average, firms with overconfident CEOs are more liquid.

[33] Existing literature shows great heterogeneity in the proportion of overconfident CEOs in their samples. It can be as low as 7% (Kolasinski & Li, 2013), 8% (Boulton & Campbell, 2016), or as high as 78.9% (Banerjee, Humphery-Jenner, Nanda, et al., 2018), 80.2% (Graham et al., 2013). This difference may be a result of sample characteristics. For example, Ferris et al. (2013) find 100% of their Australian sample and 88.5% of German sample are overconfident CEOs.

[34] This chapter uses raw *LM12*, whereas W. Huang and Mazouz (2018) use the natural logarithm of LM12 and have a mean of 0.321.

Table 3-1 Descriptive Statistics

This table reports the summary statistics for the key variables. The sample is constructed based on Compustat firms. The sample date ranges from January 1999 to December 2019. *Holder67* is an indicator variable equals one if the CEO is overconfident by following Malmendier and Tate (2005). *LM12* is the first measure of level of stock illiquidity by following W. Huang and Mazouz (2018), *Amihud* is the second measure of level of stock illiquidity. *Cash* is total cash holdings, measured by Compustat item *che* deflated by total assets *at*. *RiskyInvestments* is the sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). *Size* is firm size, natural logarithm of market capitalization (CRSP items *prc*shrout*). *Leverage* is firm leverage, the ratio to total debt to total assets. *Dividend* (dummy) is indicator variable, which equals one if *dvc* is above zero. *B/M* (*ceq/prcc_f*csho*) is book-to-market ratio that measures growth opportunity. *ROA* assets (*ebitda/at*) is return on assets-in-place measures firm performance and *Volatility* is yearly standard deviation of firm daily stock return.

	(1)	(2)	(3)	(4)
	Mean	*Median*	*Std. Dev.*	*Observations*
Holder67	0.858	1	0.349	23,325
LM12	4.262	2.988	5.958	23,325
Amihud	0.0630	0.0272	0.203	23,325
RiskyInvestments	0.0511	0.0122	0.0957	23,325
Cash	0.145	0.0801	0.167	23,325
Size	14.77	14.64	1.678	23,325
Leverage	0.235	0.209	0.214	23,325
Dividend	0.611	1	0.487	23,325
B/M	0.483	0.424	2.206	23,325
ROA	0.118	0.117	0.132	23,325
Volatility	0.0247	0.0212	0.0143	23,325

Table 3-2 Univariate Comparison

This table reports the comparison of summary statistics between firms with and without overconfident CEOs. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Overconfident CEOs (*N = 20,022*)			*Non-Overconfident CEOs* (*N = 3,303*)			*Difference in Mean*
	Mean	*Median*	*Std. Dev.*	*Mean*	*Median*	*Std. Dev.*	
LM12	3.765	2.008	5.175	7.272	4.016	8.821	3.507***
Amihud	0.0568	0.0251	0.194	0.101	0.0438	0.247	0.044***
RiskyInvestments	0.0518	0.0131	0.0944	0.0472	0.00748	0.103	-0.005***
Cash	0.151	0.0874	0.168	0.109	0.0474	0.162	-0.043***
Size	14.86	14.72	1.662	14.24	14.09	1.678	-0.626***
Leverage	0.232	0.203	0.213	0.256	0.243	0.214	0.024***
Dividend	0.599	1	0.490	0.684	1	0.465	0.085***
B/M	0.470	0.401	0.793	0.562	0.566	5.527	0.092**
ROA	0.122	0.120	0.129	0.0893	0.103	0.141	-0.033***
Volatility	0.0243	0.0208	0.0138	0.0271	0.0233	0.0164	0.003***

3.5 Empirical Results

3.5.1 Baseline Regressions

Overconfident CEOs overvalue their ability in improving firm profitability and underestimate the fluctuation of this profitability. The upward bias drives firm policies of overconfident CEOs towards a direction that is favourable in firms with rational CEOs. For example, overconfident CEOs pile up cash holdings (Y.-R. Chen et al., 2020), large cash holdings increase the stock liquidity of firms with rational CEOs since additional cash reduces uncertainty. Similarly, overconfident CEOs may also look for high borrowing, large SEOs or frequent share repurchase, which all makes firms more liquid if rational CEOs did the same. Yet these policies of overconfident CEOs can end up with contradictory consequences. Sufficient cash holdings facilitate excessive spending by overconfident CEOs in investments, which are value-decreasing (Ferris et al., 2013; Malmendier & Tate, 2005, 2008).

Conversely, when rational CEOs turn liquid assets that reduce uncertainty into illiquid assets that accumulate uncertainty, their firms become illiquid too. However, when overconfident CEOs covert internal liquidities into investments, especially risky ones, shareholders give positive feedback because investments made by overconfident CEOs increases firm value (Goel & Thakor, 2008). Consequently, investment (financial) policies that decrease (increase) stock liquidity in firms with rational CEOs should increase (decrease) stock liquidity in firms with overconfident CEOs. In brief, overconfident CEOs invest to make their firms more liquid but decrease stock liquidity due to financial preference.

The results generated by equation (3-1) are given in Table 3-3. The coefficients of *Holder67* in both columns are negatively related to dependent variables. Column 1 suggests that firms with overconfident CEOs have 1.5 days less in trading discontinuity compared with an average firm. Less zero trading days signal a greater willingness of trading, for the cost of trading is smaller and the transactions are profitable, accordingly, investors trade more and faster (W. Huang & Mazouz, 2018). Column 2 records a 0.02 reduction in *Amihud* stock illiquidity ratio for overconfident CEOs-managed firms. This means stock prices are less sensitive to trading activities, firms are less likely to suffer from aggressive selling that drives prices down. Hence, consistent with hypothesis 1a, on average CEO overconfidence increases stock liquidity by around a third (32.2%–35.5%) compared with a mean firm, which implies higher firm value (Cheung et al., 2015; Fang et al., 2009; Massa & Zhang, 2013), access to lower cost of capital (Amihud & Levi, 2022; Roosenboom et al., 2013) and

lower information asymmetry (Andres et al., 2014). Firms should benefit from CEO overconfidence, in line with the view that overconfident CEOs are preferred by shareholders as they improve firm value (Campbell, 2014), it also accounts for the disadvantages of overconfidence, as the bias in cost of external financing that leads to large cash holdings but ignores cheap alternative resources (Deshmukh et al., 2021).

Table 3-3 The Impact of CEO Overconfidence on Stock Liquidity: Baseline Regressions
This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity. The dependent variable is the level of stock illiquidity, *LM12* in column 1 and *Amihud* in column 2. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. Column 1 reports the impacts of CEO overconfidence on firm stock liquidity (*LM12*) at mean level. Column 2 reports the impacts of CEO overconfidence on firm stock liquidity (*Amihud*) at mean level. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)
	Full Sample	
	LM12	*Amihud*
Holder67	-1.513***	-0.0203***
	(0.129)	(0.00474)
Size	-3.411***	-0.0779***
	(0.0540)	(0.00198)
Leverage	0.280	-0.0202**
	(0.260)	(0.00952)
Dividend	0.269**	0.0131***
	(0.116)	(0.00425)
B/M	-0.0136	0.00105**
	(0.0131)	(0.000481)
ROA	0.227	0.0111
	(0.334)	(0.0122)
Volatility	-38.41***	2.243***
	(3.189)	(0.117)
Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
Observations	23,325	23,325
R^2	0.374	0.129

3.5.2 Impacts of Firm Policies

Having confirmed that CEO overconfidence increases stock liquidity, this section examines hypothesis 2 that assumes whether investment policy bridges the positive relation between CEO overconfidence and stock liquidity.

According to Gopalan et al. (2012), liquid assets increase stock liquidity only when these assets remain liquid, shifting the liquid assets into illiquid investments invalidates the effects. Hence, it is likely that investment policies dominate financial policies to affect stock liquidity. Given investments made by overconfident CEOs are largely funded by internal liquidities (Ferris et al., 2013; Kaplan et al., 2021; Malmendier & Tate, 2005, 2008), and overconfident CEOs are preferred by firms because of their bold investment policies (Campbell et al., 2011; Goel & Thakor, 2008)[35], CEO overconfidence should be beneficial to shareholders. There may be potential adverse influences: if investments override cash holdings, and investment plans of overconfident CEOs increase firm value, a negative relation between stock liquidity and investments made by overconfident CEOs should be observed.

To test the predictions, the model lets CEO overconfidence interact with investments in equation (3-2). Since it is the risk preference that captures the eyes of directors of boards, the investments are measured by the sum of a firm's acquisitions and innovation spendings, of which the riskiness is mirrored by inflated volatility of returns (Croci & Petmezas, 2015), divided by a firm's total assets. The model further controls a firm's cash policies. Both variables are lagged by one year. The results are in Table 3-4.

First, in columns 1 and 2, consistent with previous results, the coefficients of CEO overconfidence are negatively related to stock illiquidity. Echoing Gopalan et al. (2012), the positive value of *RiskyInvestments* indicates that illiquid assets increase uncertainty to assets-in-place and make firms more illiquid. On the contrary, the interaction between CEO overconfidence and investments is significantly inversely related to both stock illiquidity proxies. Risky investments made by overconfident CEOs significantly decrease trading discontinuity days by 5.75 days and lower price impact by 0.07 compared with rational CEOs[36], which advises the stocks of the firms cost less in transactions and induce frequent

[35] Goel and Thakor (2008) discover that it is more likely the managers take risky investments in the promotion competition will succeed the CEO position, overconfident managers who naturally prefer risks have the highest chance becoming the next CEOs.

[36] Hence, a total effect of risky investments made by overconfident CEOs can be estimated as a 0.3-day reduction in trading discontinuity, or a 0.015 reduction in price impact, while for rational CEOs, it is a 5.4-days increase trading discontinuity, or a 0.058 increase in price impact.

trading. Thus, investments increase certainty in firms with overconfident CEOs as opposed to other firms, aligning with the stance that overconfident CEOs alleviate underinvestment and produce positive value (Gervais et al., 2011). Columns 3 and 4, firm cash holdings are controlled. The regression results indicate that the conclusion remains valid, both coefficients of *Holder67* and its interaction with risky investments are significantly negative. On the flip side, when the coefficients of *Cash* indicate that cash holdings increase stock liquidity as suggested by W. Huang and Mazouz (2018), cash holdings decrease stock liquidity when held by overconfident CEOs, which potentially counts the cost of biased financial policies and the cost of deviant investment projects caused by biased financial policies[37].

In all, the results show that CEO overconfidence contributes to greater stock liquidity and risky investment portraited by acquisitions and innovation is an important way to make impacts by overconfident CEOs, which reinforces the idea that overconfident CEOs are hired because of undertaking more investments (Goel & Thakor, 2008), firms accordingly should benefit from the exploitation of CEO overconfidence in direct investments.

[37] As overconfident CEOs either overinvest or underinvest depend on amount of cash holdings, both destroy firm value (Malmendier & Tate, 2005).

Table 3-4 The Impact of CEO Overconfidence on Stock Liquidity: Mechanisms

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity through the channel of investments and cash holdings. The dependent variable is the level of stock illiquidity, *LM12* in columns 1 and 3 and *Amihud* in columns 2 and 4. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). *Cash* is lagged firm total cash holdings (*che/at*). Columns 1 and 2 report the impacts of CEO overconfidence and investment policy on firm stock liquidity at mean level. Columns 3 and 4 report the impacts of CEO overconfidence, investment policy and cash policy on firm stock liquidity at mean level. All regressions include year and firm fixed effects. For brevity, only the variables of interest are presented. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
	Full Sample			
	LM12	*Amihud*	*LM12*	*Amihud*
Holder67	-0.909***	-0.0207***	-1.054***	-0.0320***
	(0.137)	(0.00508)	(0.153)	(0.00564)
*Holder67*RiskyInvestments$_{t-1}$*	-5.754***	-0.0729*	-6.384***	-0.115***
	(1.082)	(0.0401)	(1.106)	(0.0409)
*Holder67*Cash$_{t-1}$*			2.021**	0.147***
			(0.828)	(0.0307)
RiskyInvestments$_{t-1}$	5.440***	0.0576	5.921***	0.0944**
	(1.032)	(0.0382)	(1.054)	(0.0390)
Cash$_{t-1}$			-2.498***	-0.152***
			(0.833)	(0.0308)
Control Variables	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	21,651	21,651	21,651	21,651
R^2	0.311	0.132	0.312	0.133

3.6 Robustness

3.6.1 Alternative Measure of Stock Liquidity

To confirm the results, this study also adopts the second measure of stock liquidity, i.e. the price impact index *Amihud* (Amihud, 2002). It has been widely used and tested in previous studies and yields reliable results. To construct the index of a firm, the first step is to calculate the daily ratio of the absolute value of stock returns over trading volume, followed by exporting the square root of daily ratios and deriving the average annually. The higher this index, the less liquid the firm stock is. The following sections operate the additional tests alongside the main regression. In Table 3-2 and Table 3-3, CEO overconfidence is negatively related to the *Amihud* price impact ratio, which indicates firms with overconfident CEOs are more liquid. Therefore, the conclusions are robust to alternative measures of stock liquidity.

3.6.2 CFO Overconfidence

Overconfidence does not only exist among CEOs, but other senior managers can also exhibit the same quality. For instance, a growing body of studies (Banerjee, Humphery-Jenner, Nanda, et al., 2018; Barrero, 2022; Ben-David et al., 2013; Graham et al., 2013) has indicated that some CFOs are overconfident and are similar to overconfident CEOs in making firm policies. Ben-David et al. (2013) indicate that following the miscalibrated CFOs[38] taking office, firms significantly increase their investments and debt ratio. However, comparatively, CFOs are less overconfident than CEOs (Graham et al., 2013). Therefore, this section tests if CFO overconfidence can have the same effects on stock liquidity as CEOs do.

Following the same measure of overconfidence based on option holdings, the estimates in Table 3-5 do not support the conjecture. Specifically, both coefficients of *Holder67* of CFOs in columns 1 and 2 are negatively related to stock illiquidity but are insignificant, which suggests the effects of CFOs are rather limited. Nevertheless, in column 2, the corporate investments related to CFOs are significantly negatively related to stock illiquidity, decreasing three zero trading days, implying the costs of trading are descending and it is profitable to proceed with transactions. Thus, different from overconfident CEOs, CFOs indirectly help to increase stock liquidity. There are several explanations. First, CFOs show

[38] Miscalibration is an expression of overconfidence, individuals who are miscalibrated believe they make accurate forecasts and overlook potential changes (Ben-David et al., 2013).

a lower degree of upward bias in their beliefs (Graham et al., 2013), so they do not behave as aggressively as overconfident CEOs, and cannot make the same impacts. For example, CEOs with finance education backgrounds show low investment-cash flow sensitivity (Malmendier & Tate, 2005), CFOs with more financial knowledge may be conservative compared with CEOs, and this conservatism may last even when they are promoted to CEOs. Second, CFOs are not final decision-makers, they coordinate financing plans to match the ideas of CEOs (Graham et al., 2013; Malmendier et al., 2011), therefore they only play marginal roles in decision-making and do not make significant contributions to investments. Third, some overconfident CFOs appear to be incompetent. For instance, they can make highly deviated forecasts about the market and their firms' future and are reluctant to make amendments (Ben-David et al., 2013). Insufficient expertise of CFOs may lead the decisions of CEOs in the wrong direction or exacerbate bad decisions of CEOs.

Hence, the results suggest that executives may be similarly overconfident, but it does not necessarily benefit firms the same, firms may wish to distinguish the selection process of CFOs from CEOs.

Table 3-5 Robustness: CFO Overconfidence

This table reports the robustness regression estimation of the impact of CFO overconfidence on firm stock liquidity. The dependent variable is the level of stock illiquidity *LM12*. The key independent variable is *Holder67*, an indicator variable that equals one if the CFOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 reports the impacts of CFO overconfidence on firm stock liquidity at mean level. Columns 2 reports the impacts of CEO overconfidence and investment policy on firm stock liquidity at mean level. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)
LM12 (*Dependent Var.*)	*Full Sample*	
Holder67 (*CFO*)	-0.301	-0.228
	(0.230)	(0.252)
Holder67 (*CFO*)**RiskyInvestments*		-3.229**
		(1.352)
RiskyInvestments		3.401**
		(1.330)
Size	-3.506***	-3.250***
	(0.0537)	(0.0530)
Leverage	0.438*	0.246
	(0.260)	(0.251)
Dividend	0.333***	0.211*
	(0.116)	(0.112)
B/M	-0.0140	-0.0175
	(0.0132)	(0.0120)
ROA	0.127	0.184
	(0.335)	(0.330)
Volatility	-40.73***	-32.50***
	(3.193)	(3.115)
Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
Observations	23,325	21,651
R^2	0.370	0.308

3.6.3 CEO Age

The age of CEOs can potentially affect the results. Younger CEOs have longer career horizons than older CEOs, which may contribute to differences in their risk preference and subsequent firm policies. Younger CEOs with longer career horizons care more about the firms' future, while older CEOs who are about to retire have more motives to extract private benefits (Jain et al., 2016). Accordingly, younger CEOs are more discreet in making investment decisions that can negatively affect their career, and older CEOs are more likely to jeopardize stock liquidity by participating in value-decreasing projects. If it is the case, the conclusions will not hold among the older CEOs.

However, although younger CEOs have such concerns tied to their career, no evidence indicates there exist differences among turnover rates of CEOs from different age groups, and both young and old CEOs face low turnover rates with bad acquisition outcomes. Meanwhile, acquisitions boost CEO compensation permanently, younger CEOs are strongly motivated by the incentives and take advantage of their longer career horizon to realize more of such benefits by making more acquisitions (Yim, 2013). If instead, younger CEOs decrease stock liquidity, and older CEOs drive the results, the conclusion will not hold for younger CEOs.

In either scenario, the age of CEOs may cause inconsistency in the verdicts. To minimize the concern, the CEOs are divided into two groups by median and repeat the baseline tests. The results are given in Table 3-6. The estimates presented in every column suggest negative relations between CEO overconfidence (and its interaction with investments) and stock liquidity. The coefficients of *Holder67* of younger CEOs are stronger than older CEOs, while they make no visible differences after controlling investments. The interactions reveal stronger overconfidence effects for younger CEOs. Hence, consistent with the first conjecture, younger CEOs may be better at balancing firm policies and contributing to more desirable outcomes due to longer career horizons. However, both types of CEOs are strongly negatively connected with stock illiquidity, CEO age holds some explanatory power, but it is not pivotal in driving the CEO overconfidence-stock liquidity relation. Hence, the conclusions are robust to CEO age.

Table 3-6 Robustness: CEO Age

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity by controlling CEO age. Firms are divided into two groups by CEO age median, firms with younger CEOs are in the bottom groups, otherwise in the top group. The dependent variable is the level of stock illiquidity *LM12*. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 and 2 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with younger overconfident CEOs. Columns 3 and 4 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with older overconfident CEOs. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
LM12 (*Dependent Var.*)	*Younger CEOs*		*Older CEOs*	
Holder67	-1.725***	-0.645***	-0.950***	-0.634***
	(0.196)	(0.213)	(0.199)	(0.209)
*Holder67*RiskyInvestments*		-8.189***		-4.127**
		(1.512)		(1.716)
RiskyInvestments		7.230***		4.654***
		(1.447)		(1.639)
Size	-3.731***	-3.491***	-3.070***	-2.854***
	(0.0772)	(0.0778)	(0.0890)	(0.0864)
Leverage	-0.308	-0.622*	0.554	0.528
	(0.372)	(0.367)	(0.407)	(0.388)
Dividend	0.268	0.228	0.186	0.0943
	(0.169)	(0.167)	(0.177)	(0.170)
B/M	-0.0213	-0.0283*	0.153*	0.248***
	(0.0146)	(0.0158)	(0.0916)	(0.0926)
ROA	0.337	0.505	0.299	-0.336
	(0.445)	(0.433)	(0.556)	(0.557)
Volatility	-48.90***	-42.11***	-26.12***	-16.30***
	(4.420)	(4.326)	(4.825)	(4.752)
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	12,335	11,355	12,335	10,052
R^2	0.366	0.305	0.354	0.309

3.6.4 Corporate Governance

Corporate governance can also affect stock liquidity. On the one hand, improved governance may directly improve stock liquidity by reducing information asymmetry at both country and firm levels. Regulations are important to control the misbehaviour of both firms and investors. For example, explicit trading rules deter market manipulation (Bhide, 1993; Cumming et al., 2011), disclosure of stock holdings of informed traders delivers private information and discourages informed trading (Agarwal et al., 2015), and compulsory requirements for corporate social responsibility generates a smaller information gap (Roy et al., 2022). Disclosure by firms also decreases information asymmetry, firms may intentionally publish more information when external information is less (Balakrishnan et al., 2014). Transparency of information prevents investors making adverse selections, meanwhile being exposed to the same large volume of firm information disclosed, investors tend to show more homogeneity in their strategies. Accordingly, market participants are attracted to these firms and increase trading (Chung et al., 2010; Jain et al., 2016).

On the other hand, governance can affect stock liquidity by disciplining overconfident CEOs. Well-governed firms can replace overconfident CEOs who underperform with overconfident CEOs with good performance or do not hire overconfident CEOs (Campbell, 2014; Campbell et al., 2011). Or firms can intervene in CEO decisions. Strong and independent boards restrain overconfident CEOs from making value-decreasing projects (Banerjee et al., 2015; Goel & Thakor, 2008; Kolasinski & Li, 2013). For example, under an improved board structure, overconfident CEOs in a median firm cut capital expenditures by 52% and fixed assets by 39.7%, and the sensitivity of investments to cash flows and risk exposure also lowers. Accordingly, not only the overall firm performance and the value of investments increase, but also cash dividends, which creates long-term shareholder wealth (Banerjee et al., 2015).

Moreover, corporate governance can cause endogeneity issues. Ideally, options trading should reflect personal beliefs in firms' prospects instead of the wills of other parties. However, it is likely option holding is just a way of management. CEOs may hold options because of the boards and investors' expectations to keep incentives high (Campbell et al., 2011). CEOs may also hold more options only to depict a committed figure, so CEOs can build stronger leadership to connect with employees and clients more closely (Phua et al., 2018). If option holdings only represent a governance measure, then the CEOs will be incorrectly recognized as overconfident, which distorted the results.

To mitigate this concern, sample firms are first required to be in the U.S. market to ensure

the consistency of exposure to regulations, and the quality of corporate governance is controlled by the E-index (Bebchuk et al., 2008; Campbell et al., 2011). To judge if a firm is well governed, there are six criteria according to (Bebchuk et al., 2008), namely staggered boards, restricted bylaw amendments, restricted charter amendments, supermajority approval for mergers, poison pills, and golden parachutes. Staggered boards limit the number of directors who can be replaced each year, which results in a concentration of power on the boards. Voting restrictions require a large number of voters to change corporate bylaws and charters, which put sanctions on shareholder ability to intervene in management. Golden parachutes guarantee that senior executives will receive large compensation following involuntary changes in employment, such as termination of tenure. The supermajority requirement of mergers also asks a mass of shareholders to participate in the vote for mergers, it protects shareholders from hostile takeovers. Poison pills also resist hostiles by granting existing shareholders the right to buy more shares at low costs when acquirers have obtained a significant proportion of shares. Firms get one point respectively if they have staggered boards, voting restrictions on bylaw and charter amendments, and golden parachute, they also get one point respectively if they do *NOT* have a supermajority requirement for mergers and poison pills. Firms with good governance should score three points or lower.

The sample firms are split into good and poor governance groups and repeat tests by equation (3-1), if corporate governance drives the results, then the conclusion will only hold for the good governance group. The results are given in Table 3-7. All four columns display negative relations between *Holder67* and stock liquidity proxies, the coefficients of interactions between overconfidence and investments also remain significant and negative, therefore, corporate governance does not influence the results and the conclusions are robust.

Table 3-7 Robustness: Corporate Governance

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity by controlling corporate governance. Firms are divided into two groups by corporate governance, which is measured by E-Index by following Bebchuk et al. (2008). The dependent variable is the level of stock illiquidity *LM12*. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 and 2 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with poor governance. Columns 3 and 4 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with good governance. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
LM12 (*Dependent Var.*)	*Poor Governance*		*Good Governance*	
Holder67	-1.847***	-1.038***	-1.908***	-1.057***
	(0.238)	(0.250)	(0.307)	(0.319)
*Holder67*RiskyInvestments*		-5.308***		-7.602***
		(1.662)		(2.572)
RiskyInvestments		5.994***		5.257**
		(1.561)		(2.386)
Size	-4.114***	-3.848***	-3.941***	-3.575***
	(0.106)	(0.105)	(0.172)	(0.169)
Leverage	0.595	-0.0429	2.274***	2.014***
	(0.559)	(0.536)	(0.801)	(0.759)
Dividend (dummy)	0.629***	0.465**	0.208	0.225
	(0.220)	(0.209)	(0.317)	(0.298)
B/M	-0.0158	-0.0253*	0.549***	0.435***
	(0.0149)	(0.0136)	(0.143)	(0.129)
ROA	2.443***	2.647***	-2.496*	-3.266**
	(0.548)	(0.547)	(1.386)	(1.316)
Volatility	-27.42***	-21.31***	-99.84***	-94.76***
	(4.541)	(4.184)	(10.00)	(9.212)
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	9089	8155	4330	3872
R^2	0.411	0.357	0.512	0.467

3.6.5 Endogeneity: Inside Information

One endogeneity concern over the overconfidence measure is inside information. If the option-holding decisions are fully subject to personal beliefs, rational CEOs should diversify their positions once they can because of risk aversion, whereas overconfident CEOs will continue to hold as they underestimate risks and believe in their abilities to increase returns. However, if rational CEOs hold private information that implies future returns of their firms will increase, they may not to exercise options (Banerjee et al., 2015; Campbell, 2014; Campbell et al., 2011; Malmendier & Tate, 2005, 2008; Malmendier et al., 2011). Alternatively, some CEOs may hold more options because they manipulate information disclosure, such as reveal good news but hide bad news, to inflate equity value (Banerjee et al., 2015; Banerjee, Humphery-Jenner, Nanda, et al., 2018). In either situation, it is inside information driving the option holdings rather than overconfidence. Therefore, some rational CEOs can be incorrectly classified as overconfident CEOs, and the results can be biased.

To minimize the concern, following (Malmendier & Tate, 2005), CEOs are divided into two groups by who gains or loses money in their unexercised options. CEOs who gain profits from their option holdings are more likely to hold inside information, while CEOs who lose appear to be overconfident. Overconfident CEOs should make judgements solely on their biased views on returns and risks, which incurs a loss. Conversely, inside information convinces rational CEOs that they can benefit from holding more options and receiving positive returns, not diversifying the holdings. Consequently, if inside information drives the results, then the results should not hold in the group that suffers a loss in option holdings.

The gain or loss in option holdings is computing the yearly change in the value of CEO unexercised exercisable options, CEOs lose when they experience a decrease in the value of options they hold. The results are given in Table 3-8. The estimates indicate that inside information does not exert influence on results. In both *Gain* and *Loss* groups, CEO overconfidence and its interaction with investments are significantly negatively related to stock illiquidity. The conclusion is robust to controlling inside information.

Table 3-8 Endogeneity: Inside Information

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity by controlling inside information. Firms are divided into two groups by whether CEOs gain profits from their option holdings by following Malmendier and Tate (2005). The dependent variable is the level of stock illiquidity *LM12*. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 and 2 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with CEOs gain profits from option holdings. Columns 3 and 4 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with CEOs lose profits from option holdings. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
LM12 (*Dependent Var.*)	*Gain*		*Loss*	
Holder67	-1.659***	-0.779***	-0.977***	-0.586**
	(0.193)	(0.194)	(0.238)	(0.254)
*Holder67*RiskyInvestments*		-5.011***		-7.928***
		(1.481)		(1.812)
RiskyInvestments		4.733***		7.437***
		(1.406)		(1.716)
Size	-3.501***	-2.987***	-3.465***	-3.442***
	(0.0888)	(0.0846)	(0.0993)	(0.0993)
Leverage	0.339	-0.0127	0.226	0.215
	(0.434)	(0.391)	(0.447)	(0.448)
Dividend	0.472**	0.0463	0.478**	0.455**
	(0.195)	(0.178)	(0.202)	(0.202)
B/M	0.391***	0.721***	0.0916**	0.0877*
	(0.136)	(0.206)	(0.0464)	(0.0464)
ROA	0.841	1.483***	1.362**	1.570***
	(0.563)	(0.544)	(0.600)	(0.602)
Volatility	-42.58***	-31.10***	-42.50***	-43.41***
	(5.917)	(5.351)	(5.772)	(5.768)
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	10,489	8815	7423	7423
R^2	0.429	0.328	0.318	0.320

3.6.6 Endogeneity: Endogenously Matching

Finally, a concern over endogeneity is whether the decisions of employment of overconfident CEOs are made entirely exogenously (Y.-R. Chen et al., 2020; Deshmukh et al., 2021; Malmendier & Tate, 2005), which means firms may intentionally choose overconfident CEOs due to unknown reasons. If the match between overconfident CEOs and firms is predetermined by omitted factors, the empirical results can be biased.

Malmendier and Tate (2005) argue firms that identify overconfident CEOs *ex-ante* can be distinguished and excluded, as firms will take observable actions that tackle the negative effects of overconfident CEOs. This chapter takes several steps to address the issue. First, this chapter controls firm and year fixed effects alongside all the tests (Deshmukh et al., 2021; Malmendier & Tate, 2005; Malmendier et al., 2011; Sen & Tumarkin, 2015), the results are empirically significant. A second method to mitigate the effects of endogenous matching is to restrict samples by CEO tenures (Aktas et al., 2019; Hirshleifer et al., 2012). According to previous studies (Aktas et al., 2019; Hirshleifer et al., 2012), the effect of endogenous matching weakens over time, and a newly appointed CEO is more likely to be endogenously determined. The second solution is then to treat the sample by excluding CEOs who have a tenure of less than one, three, or five years respectively, and repeating the baseline model. Any missing appointment year is set as 1999 and any missing leaving year is set as 2019, which are the start and end years of the sample period. The results are given in Table 3-9. The estimates in all columns clearly show that CEO overconfidence and their investments increase stock liquidity for either newly appointed CEOs or CEOs with longer terms.

To further alleviate the concerns over endogenously matching, the third method is applying instrumental variable (IV) with the 2SLS strategy. Following Deshmukh et al. (2021), the probability of the overconfident CEO is hired as the instrumental variable. According to Deshmukh et al. (2021), with more overconfident potential CEOs, companies are less likely to choose rational CEOs regardless of their preference. Besides, it is also unlikely that there exists a causality between the likeliness of candidate CEOs being chosen and stock liquidity. The instrument *Incidence* is computed as the proportion of overconfident CEOs over the total CEOs appointed in the same period. Deshmukh et al. (2021) do so by considering the same year and month. However, due to limited data, the condition is relaxed by only considering the same year. Therefore, the instrument *Incidence* is the likelihood of hiring an overconfident CEO is the proportion of overconfident CEOs over total CEOs appointed in the same year. The first stage of regression arranges as follows:

$$Holder67_{i,t}(instrumented)=\alpha+\beta_1 Incidence_{i,t}+\beta_2 X_{i,t}+fe_{i,t}+\varepsilon_{i,t} \quad (3\text{-}3)$$

$$Holder67_{i,t}(instrumented)=\alpha+\beta_1 Incidence_{i,t}+\beta_2 Incidence_{i,t}\times RiskyInvestments_{i,t-1} +\beta_3 RiskyInvestments_{i,t-1}+\beta_4 X_{i,t}+fe_{i,t}+\varepsilon_{i,t} \quad (3\text{-}4)$$

Where *Incidence* is the instrumental variable. *RiskyInvestments* is firm spending on acquisitions and innovation, lagged by one year, $X_{i,t-1}$ includes all the control variables from equation (3-1), $fe_{i,t}$ is year/firm fixed effects and $\varepsilon_{i,t}$ is the error term.

Table 3-10 shows the results. Columns 2 and 4 show the results of first stage regression from equation (3-3) and (3-4) respectively. The instrument *Incidence* is positively related to overconfidence proxy *Holder67*, consistent with Deshmukh et al. (2021). The results in columns 1 and 3 indicate that instrumented *Holder67* and its interaction with investments are still significantly negatively related to stock illiquidity, which means CEO overconfidence increases stock liquidity. In all, the results and conclusions are robust to endogenously matching.

Table 3-9 Endogeneity: CEO Tenures

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity by controlling CEO tenures. Firms are filtered into three groups, in which CEOs with tenures less than 1, 3 and 5 years are excluded respectively. The dependent variable is the level of stock illiquidity *LM12*. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 and 2 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with CEOs having a tenure at least 1 year. Columns 3 and 4 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with CEOs having a tenure at least 3 years. Columns 5 and 6 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with CEOs having a tenure at least 5 years. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)
LM12 (*Dependent Var.*)	*Tenure > 1 year*		*Tenure > 3 years*		*Tenure > 5 years*	
Holder67	-1.457***	-0.866***	-1.440***	-0.875***	-1.588***	-0.966***
	(0.130)	(0.137)	(0.134)	(0.141)	(0.146)	(0.151)
*Holder67*RiskyInvestments*		-5.692***		-5.937***		-6.689***
		(1.080)		(1.110)		(1.160)
RiskyInvestments		5.473***		5.389***		5.888***
		(1.030)		(1.058)		(1.103)
Size	-3.421***	-3.168***	-3.428***	-3.163***	-3.453***	-3.185***
	(0.0553)	(0.0544)	(0.0583)	(0.0574)	(0.0644)	(0.0627)
Leverage	0.352	0.200	0.315	0.160	0.452	0.162
	(0.265)	(0.255)	(0.274)	(0.263)	(0.311)	(0.297)
Dividend	0.247**	0.169	0.344***	0.271**	0.475***	0.390***
	(0.118)	(0.113)	(0.122)	(0.117)	(0.135)	(0.129)
B/M	-0.0148	-0.0187	-0.0127	-0.0162	0.123***	0.123***
	(0.0130)	(0.0118)	(0.0129)	(0.0117)	(0.0452)	(0.0409)
ROA	0.338	0.308	0.222	0.166	-0.331	-0.596
	(0.346)	(0.338)	(0.379)	(0.362)	(0.422)	(0.404)
Volatility	-35.77***	-27.93***	-36.56***	-28.74***	-35.63***	-30.00***
	(3.237)	(3.124)	(3.355)	(3.229)	(3.640)	(3.406)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22,360	20,773	20,710	19,254	18,350	17,046
R^2	0.377	0.314	0.382	0.318	0.384	0.323

Table 3-10 Endogeneity: Instrumental Variables

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity from a 2SLS framework. The dependent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero, in columns 2 and 4. The key independent variable is the odds that an overconfident candidate can be elected as next CEO (*Incidence*) by following Deshmukh et al. (2021) in columns 2 and 4. Columns 2 and 4 reports the estimation of the first stage regression where CEO overconfidence (*Holder67*) is instrumented by *Incidence*. The dependent variable is the level of stock illiquidity *LM12* in columns 1 and 3. The key independent variable is *RiskyInvestments*, the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 and 3 reports the main estimation. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
		Full Sample		
	LM12	*Holder67*	*LM12*	*Holder67*
Holder67 (*instrumented*)	-2.091***		-1.520***	
	(0.264)		(0.289)	
Holder67 (*instrumented*)**RiskyInvestments*			-4.357***	
			(1.551)	
RiskyInvestments			4.206***	
			(1.423)	
Incidence		0.630***		0.591***
		(0.00792)		(0.00840)
Control Variables	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	23,325	23,049	21,651	21,651
R^2	0.545	0.718	0.534	0.719

3.7 Conclusions

This chapter investigates the relationship between CEO overconfidence and stock liquidity. Firms with rational CEOs become more liquid when rational CEOs implement firm policies that reduce uncertainty, for example, more cash holdings increase stock liquidity. Overconfident CEOs apply the same policies as rational CEOs at a higher level, e.g. overconfident CEOs save more cash than rational CEOs, which should increase stock liquidity more. Yet the abnormally high cash levels root in inaccurate judgements on firms' returns, which thus incurs high costs, such as squandering on value-decreasing projects, and increases uncertainty. On the contrary, increasing investments that create uncertainty in rational firms do the opposite to overconfident firms; overconfident CEOs mitigate underinvestment and improve firm value by making risky investments, which decrease uncertainty. Hence, this chapter finds that on average, CEO overconfidence increases firm stock liquidity by 32.2%–35.5%, and it is investment contributing to such increases.

The results hold by considering alternative explanations of other executive and firm characteristics. Other senior executives such as CFOs do not exert the same influence on stock liquidity, even when they are overconfident too. Lower CEO age makes for a longer career horizon, which induces CEOs to behaviour differently since they must plan their future carefully. Corporate governance can also affect CEO behaviour if the board act in the interest of shareholders and discipline CEOs. Results indicate the conclusions are robust to controlling CEO age and governance. Finally, this chapter controls inside information, and CEO tenures and use instrumental variables to alleviate potential endogeneity issues of the measure of overconfidence, and conclusions hold after these steps.

Overall, these findings provide additional support that overconfident CEOs increase firm value, and it is beneficial for firms to prioritize candidates who show such traits in CEO selection. Since higher stock liquidity facilitates low-cost external financing, the boards act in the interests of shareholders and should also discipline overconfident CEOs who overvalue cash holdings.

However, there are some limitations in this chapter as this study does not consider the feedback effects of stock liquidity. For example, increased stock liquidity enhances corporate governance through exits, i.e. shareholders can sell their shares more easily. Exit provides two routes that affect firm performance. On the one hand, a large volume of trading may reduce stock prices and devalue the value of firm securities owned by managers; accordingly, managers endeavour to avoid the situation and improve firm performance *ex-ante* (Cheung et al., 2015; Edmans et al., 2013). Given the results show firms with overconfident CEOs

are less likely to suffer from price impact, it is unclear whether threats of exit work for these firms as a channel of governance. On the other hand, more informed trading makes stock prices contain opinions of investors on firm development, managers should receive such messages and adjust policies to improve firm performance *ex-post* (Fang et al., 2009). Although Burks et al. (2013) suggest that overconfident CEOs search for information to confirm their positive beliefs, it is unknown whether such information hunting is discriminatory. In other words, they intentionally focus on what fits in their minds but ignore critiques. Therefore, it is also unclear whether the decision-making by overconfident CEOs involves alternative voices. These problems remain for future research.

Conclusions

This thesis mainly covers the theme of cash holdings and CEO overconfidence, with each chapter using different emphases. Chapter 1 addresses the impact of negative shocks, chapter 2 examines value of cash holding compositions, and chapter 3 observes changes in stock liquidity. This chapter concludes the major findings and proposes potential directions for future research.

Chapter 1 investigates how investment-cash holding sensitivity changes when there is operation loss (operating cash flows disruptions). This chapter finds that operation loss makes corporate investments less sensitive to cash holdings. The similar changes in investment sensitivity to optimal and excess cash indicates firms are indifferent to target levels. There can be an optimal cash level, whereas firms do not see excess cash holdings above the optimal level different from the optimal cash (the cash holdings at the optimal level). This contrasts with literature that implicitly suggest that excess cash is distinguished from normal cash. Moreover, the decrease in post-*Loss* investment sensitivity to cash holdings is only observed among high cash firms. It can be counterintuitive because high cash levels of some firms might only be transitory. A large cash reserve suggests heavy reliance of a firm on cash holdings, these firms save more but also spend more. Firms such as financially constrained firms, debt paying firms, poorly governed firms, and domestic-only operated firms show such traits. Adversely, low-cash firms like financially constrained firms and well-governed firms are found to increase their post-*Loss* investment-cash holding sensitivity. Non-debt paying firms and multinational firms do not increase their investment sensitivity to cash holdings, but they experience a smaller decrease.

This chapter contributes to literature on excess cash by showing it is not considered different from optimal cash in general. It also relates to studies about cash flows and negative shocks. The allocation of cash flows can affect firm cash holdings, which subsequently change their behaviour amid shocks.

Chapter 2 looks deep into cash holdings *per se*. The academic definition of cash holdings comprises two components, cash and cash equivalent, and short-term investments. This chapter shows generally the value of cash (cash and cash equivalent) is higher than short-term investments. Since the precautionary motive is leading the cash holding behaviour, the high liquidity feature of cash better aligns with the purpose of cash savings. This difference is more pronounced when firms have debts to pay down in the next two years. Additionally, chapter 2 shows the value of cash and short-term investments reverses with some firm traits.

The value of short-term investments becomes higher than cash when firms have less short-term liquidity needs, less financial constraints, and inferior corporate governance. This is because in these firm, the liquidity of cash is no longer needed. With fewer growth opportunities, low liquidity needs firms have less demand for cash holdings to make investments. Financially unconstrained firms use more external financing instead of cash holdings. And more cash holdings in poorly governed only leads to wasteful spending. Hence, the illiquidity of short-term investments is treasured, as it not only makes more yields, but also makes difficulty for self-interested agents to dissipate.

This chapter contributes to the literature recording how firms manage their non-cash cash holdings (Azar et al., 2016; Cardella et al., 2021; Duchin et al., 2017). And it relates to the literature about the value of cash holdings. Particularly this chapter complements the corporate governance-focused works (Aktas et al., 2019; A. Dittmar & Mahrt-Smith, 2007; A. Dittmar et al., 2003; Haw et al., 2011; Tong, 2011), showing changes in the composition of cash holdings might reduce agency costs.

Chapter 3 investigates the changes in stock liquidity when the firms are managed by overconfident CEOs. This chapter finds that stock liquidity is positively related to CEO overconfidence. And overconfident CEOs increase stock liquidity by making more investments but reducing stock liquidity by large cash holdings. Although in firms with rational CEOs, stock liquidity increases for large cash holdings and decreases for more investments; the results reverse in firms with overconfident CEOs. Rational CEOs decrease uncertainty by increasing cash holdings and increase uncertainty by converting cash holdings into investments. Conversely, overconfident CEOs mitigate underinvestment by making more investments, but high cash holdings facilitate wasteful spending. Therefore, CEO overconfidence increases firm stock liquidity by 32.2%–35.5% on average. Additional tests indicates that overconfident CFOs do not increase stock liquidity as CEOs do. And the results hold after controlling CEO age and governance.

Chapter 3 contributes to the literature suggesting the impacts of CEO overconfidence (Campbell, 2014; Campbell et al., 2011; Ferris et al., 2013; Goel & Thakor, 2008; Heaton, 2002; Malmendier & Tate, 2005, 2008). This chapter explains that the positive effects of CEO overconfidence dominate negative effects. This chapter also extends the works on finding determinants of stock liquidity (Andres et al., 2014; De Cesari et al., 2011; Gopalan et al., 2012; W. Huang & Mazouz, 2018; Kothare, 1997). This chapter shows in a framework distinguished from the common assumption of rationality, the effects of firm policies on stock liquidity work in the opposite direction.

This thesis also has some limitations. In chapter 1, it is observed that the changes in

investment-cash holding sensitivity after operation loss in different groups of firms are in opposite directions. However, the differences in post-*Loss* investment-cash holding sensitivity of cross-sectional groups are statistically insignificant. One possibility is that operation loss forces these firms to adjust their investment sensitivity to cash holdings to a similar level.

Chapter 2 also stresses intra-firm comparisons of cash and short-term investments value, which leaves a gap for some cross-sectional results. While the value of short-term investments is different from cash in a firm with low liquidity needs, the value of short-term investments in low liquidity needs firms is not statistically different from the value of short-term investments in high liquidity needs firms. Not all the cross-sectional comparisons in this chapter are statistically insignificant, but existence of such a phenomenon may suggest the complexity of how firms weigh extra yields and reduced liquidity.

Chapter 3 looks at the impacts of CEO overconfidence on stock liquidity. Increased stock liquidity represents the positive attitudes of the market towards the firm. However, greater stock liquidity can also become a tool for discipline against the cash-wasting behaviour of overconfident CEOs. There is no answer to whether overconfident CEOs proactively receive these market voices and change their behaviour.

This thesis leaves these questions to the future.

Appendix A

1. Appendix A

The Appendix A lists the tables from Chapter 1.

Table 1-1 Descriptive Statistics

This table reports the summary statistics for the key variables. The sample is constructed based on Compustat firms. The sample date ranges from January 1989 to December 2019. *Investment* is the sum of *capx*, *aqc* and *xrd* deflated by net total assets. *Cash* is cash holdings, measured by Compustat item *che* deflated by net total assets, *Loss* is an indicator variable representing operation loss, equals one if *oancf* is negative and equals zero otherwise. *Q* is Tobin's Q, calculated through market-based values. *Cash Flow* is income before extraordinary items plus depreciation and amortization scaled by total assets. *Size* is firm's size, measured by natural logarithm of total assets. *Leverage* is the ratio of short- and long-term debt over market value of common equity. *Dividend* is indicator variable, equal to one if the firm pays cash dividend or repurchases shares.

	(1) *Mean*	(2) *Median*	(3) *Std. Dev.*	(4) *Observations*
Investment	0.851	0.148	5.105	26,111
Capital Expenditures	0.0628	0.0386	0.0797	26,111
Acquisitions	0.0228	0	0.321	26,111
R&D Expenses	0.766	0.0461	5.103	26,111
Cash	1.993	0.214	11.64	26,111
Loss	0.307	0	0.461	26,111
Q	2.682	1.803	4.332	26,111
Cash Flow	-0.0918	0.0625	0.659	26,111
Size	5.948	5.883	2.304	26,111
Leverage	0.158	0.0849	0.198	26,111
Dividend	0.364	0	0.481	26,111

Table 1-2 Univariate Comparison

This table reports the comparison of summary statistics between firms with and without operation loss. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Without Operation Loss (*N = 18,105*)			*With Operation Loss* (*N = 8,006*)			*Difference in Mean*
	Mean	*Median*	*Std. Dev.*	*Mean*	*Median*	*Std. Dev.*	
Investment	0.183	0.114	0.452	2.361	0.482	9.014	-2.178***
Capital Exp.	0.0564	0.0391	0.0585	0.0774	0.0370	0.113	-0.021***
Acquisitions	0.0354	0	0.0831	-0.00566	0	0.564	0.041***
R&D Expenses	0.0916	0.0235	0.440	2.290	0.387	9.008	-2.198***
Cash	0.436	0.140	1.853	5.513	0.917	20.41	-5.077***
Q	2.252	1.714	2.007	3.653	2.198	7.123	-1.401***
Cash Flow	0.0872	0.0921	0.117	-0.496	-0.283	1.073	0.584***
Size	6.737	6.723	2.091	4.163	4.069	1.680	2.575***
Leverage	0.175	0.116	0.198	0.121	0.0249	0.192	0.054***
Dividend	0.461	0	0.498	0.145	0	0.352	0.315***

Table 1-3 Investment-Cash Holding Sensitivities and Operation Loss: Baseline Regressions

This table reports the regression estimation of the investment sensitivities to cash holdings with and without operation loss. The dependent variable is *Investment* (*capx + aqc + xrd)*/(*at - che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Columns 1 and 2 report the estimation without controlling lagged operation loss. Columns 3 and 4 report the estimation with controlling lagged operation loss. Columns 1 and 3 controls long-term investment opportunities using *Cash Flow* (*EBITDA*). Columns 2 and 4 controls long-term investment opportunities using *Cash Flow* (*EBIT*). All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
Investment (*Dependent Var.*)		*Full Sample*		
Cash	0.161***	0.156***	0.149***	0.143***
	(0.0158)	(0.0158)	(0.0184)	(0.0185)
Loss	-0.209***	-0.158**	-0.260***	-0.201***
	(0.0791)	(0.0794)	(0.0726)	(0.0728)
$Loss_{t-1}$			-0.241***	-0.239***
			(0.0724)	(0.0728)
*Cash*Loss*	0.0773***	0.0817***	0.130***	0.133***
	(0.0158)	(0.0158)	(0.0146)	(0.0147)
$Cash*Loss_{t-1}$			0.124***	0.125***
			(0.0164)	(0.0165)
Control Variables	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	26,111	26,111	23,152	23,152
R^2	0.319	0.312	0.498	0.493

Table 1-4 Investment-Cash Holding Sensitivities and Operation Loss: Optimal and Excess Cash

This table reports the regression estimation of investment sensitivities to optimal and excess cash holdings with and without operation loss. The dependent variable is *Investment* (*capx + aqc + xrd)*/(*at - che*). The independent variables are *Optimal Cash* (*estimated by equation (1-2)*), *Excess Cash* (*Cash – Optimal Cash*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Column 1 reports the estimation with including both optimal and excess cash holdings in the regression. Column 2 reports the estimation with including optimal cash holdings only. Column 3 reports the estimation with including excess cash holdings only. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
Investment (*Dependent Var.*)		*Full Sample*	
Optimal Cash	1.505***	1.730***	
	(0.552)	(0.660)	
Excess Cash	0.162***		0.176***
	(0.0161)		(0.0150)
Loss	-0.238*	-0.269*	0.0257
	(0.126)	(0.151)	(0.0854)
*Optimal Cash*Loss*	0.0817***	0.0770**	
	(0.0303)	(0.0339)	
*Excess Cash*Loss*	0.0757***		0.0616***
	(0.0161)		(0.0150)
Control Variables	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
Observations	25,825	25,825	25,825
R^2	0.319	0.022	0.319

Table 1-5 Investment-Cash Holding Sensitivities and Operation Loss: Size of Cash Holdings

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by the size of cash reserves. Firms are partitioned into low (*Low Cash*) and high cash (*High Cash*) groups by the median. The dependent variable is *Investment* (*capx + aqc + xrd*)/(*at - che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Column 1 reports the estimation of low cash firms. Column 2 reports the estimation of high cash firms. Column 3 reports the *p*-values for the difference in the coefficients of *Cash*, *Loss* and *Cash*Loss* between low and high cash firms. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
Investment (*Dependent Var.*)	*Low Cash*	*High Cash*	*p-values*
Cash	-0.0813***	0.158***	0.000
	(0.0211)	(0.0233)	
Loss	-0.0250***	-0.439***	0.0025
	(0.00461)	(0.161)	
*Cash*Loss*	0.167***	0.0815***	0.494
	(0.0438)	(0.0233)	
Control Variables	Yes	Yes	
Year & Firm Fixed Effects	Yes	Yes	
Observations	13,061	13,050	
R^2	0.220	0.327	

Table 1-6 Investment-Cash Holding Sensitivities and Operation Loss: Financial Constraints

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by financial constraints. Firms are partitioned into constrained (*Con.*) and unconstrained (*Uncon.*) groups by the *SA Index*, *WW Index* and *Sufi* credit lines access respectively. The dependent variable is *Investment* (*capx* + *aqc* + *xrd*)/(*at* - *che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). *Panel A* reports the main estimation. *Panel B* reports the *p*-values for the difference in the coefficients of *Cash*, *Loss* and *Cash*Loss* between constrained and unconstrained firms. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)
Investment	*SA Index*		*WW Index*		*Sufi*	
(*Dependent Var.*)	*Con.*	*Uncon.*	*Con.*	*Uncon.*	*Con.*	*Uncon.*
			Panel A Main Results			
Cash	0.207***	0.108***	0.134***	0.150***	0.112***	0.0345**
	(0.0328)	(0.00298)	(0.0159)	(0.0255)	(0.0106)	(0.0161)
Loss	-0.265	-0.0800***	-0.0232	-0.450***	-0.0559	-0.220***
	(0.221)	(0.0106)	(0.0749)	(0.139)	(0.0571)	(0.0350)
*Cash*Loss*	0.0614*	0.124***	0.00602	0.161***	-0.00110	0.214***
	(0.0328)	(0.00393)	(0.0157)	(0.0256)	(0.0107)	(0.0179)
Control Var.	Yes	Yes	Yes	Yes	Yes	Yes
Year &Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	7424	7430	13,050	13,061	10,455	692
R^2	0.368	0.548	0.259	0.387	0.258	0.701
			Panel B p-values			
Cash		0.0486		0.0056		0.6017
Loss		0.0884		0.0389		0.4232
*Cash*Loss*		0.629		0.694		0.1953

Table 1-7 Investment-Cash Holding Sensitivities and Operation Loss: Joint Effects of Cash Size and Financial Constraints

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by the size of cash reserves and financial constraints jointly. Firms are partitioned into four groups, low cash constrained firms, high cash constrained firms, low cash unconstrained firms and high cash unconstrained firms. The dependent variable is *Investment* (*capx* + *aqc* + xrd)/(*at* - *che*). The independent variables are *Cash* (*che/(at* - *che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). *Panel A* reports the estimation of constrained firms. *Panel B* reports the estimation of unconstrained firms. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)
Investment	*SA Index*		*WW Index*		*Sufi*	
(*Dependent Var.*)	*Low Cash*	*High Cash*	*Low Cash*	*High Cash*	*Low Cash*	*High Cash*
			Panel A Constrained			
Cash	0.0222	0.199***	-0.102***	0.142***	-0.112***	0.116***
	(0.0770)	(0.0398)	(0.0288)	(0.0245)	(0.0284)	(0.0172)
Loss	-0.0136	-0.542	-0.0446***	-0.0912	-0.0237***	-0.0923
	(0.0112)	(0.336)	(0.00665)	(0.162)	(0.00677)	(0.136)
*Cash*Loss*	0.0183	0.0707*	0.367***	-0.00247	0.158**	-0.00516
	(0.105)	(0.0397)	(0.0610)	(0.0243)	(0.0650)	(0.0174)
Control Var.	Yes	Yes	Yes	Yes	Yes	Yes
Year & Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	2,127	5,297	7,068	5,982	6,040	4,415
R^2	0.387	0.376	0.233	0.273	0.266	0.276
			Panel B Unconstrained			
Cash	-0.113***	0.108***	-0.0804**	0.129***	0.0481	0.0349
	(0.0348)	(0.00445)	(0.0323)	(0.0363)	(0.125)	(0.0258)
Loss	-0.0142	-0.158***	-0.00918	-0.784***	-0.0609	-0.292***
	(0.00893)	(0.0238)	(0.00655)	(0.273)	(0.0646)	(0.0714)
*Cash*Loss*	0.164*	0.128***	0.0132	0.183***	-0.902	0.211***
	(0.0878)	(0.00593)	(0.0654)	(0.0365)	(1.217)	(0.0299)
Control Var.	Yes	Yes	Yes	Yes	Yes	Yes
Year & Firm FE	Yes	Yes	Yes	Yes	Yes	Yes
Observations	4200	3230	5993	7068	452	240
R^2	0.054	0.588	0.172	0.390	0.149	0.816

Table 1-8 Investment-Cash Holding Sensitivities and Operation Loss: Debt Retirement

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by debt retirement status. Firms are partitioned into no debt due (*No Debt Due*) and with debt due (*With Debt Due*) groups by whether they have debt repayments due in each year of a five-years period yearly. A firm can be with debt due (*dd1 > 0*) in *Year 1* but has no debt due (*dd2 = 0*) in *Year 2*. The dependent variable is *Investment* (*capx + aqc + xrd*)/(*at - che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). *Panel A* reports the estimation of firms with no debt due. *Panel B* reports the estimation of firms with debt due. *Panel C* reports the *p*-values for the difference in the coefficients of *Cash*, *Loss* and *Cash*Loss* between firms with and with no debt due. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)
Investment (*Dependent Var.*)	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
			Panel A No Debt Due		
Cash	0.149***	0.144***	0.166***	0.157***	0.154***
	(0.0309)	(0.0292)	(0.0270)	(0.0253)	(0.0237)
Loss	-0.270	-0.285	-0.291	-0.272	-0.242
	(0.229)	(0.218)	(0.198)	(0.172)	(0.154)
*Cash*Loss*	0.0869***	0.0939***	0.0775***	0.0783***	0.0814***
	(0.0308)	(0.0291)	(0.0270)	(0.0253)	(0.0237)
Control Variables	Yes	Yes	Yes	Yes	Yes
Year & Firm FE	Yes	Yes	Yes	Yes	Yes
Observations	8791	9310	10,017	11,479	12,719
R^2	0.310	0.319	0.335	0.313	0.323
			Panel B With Debt Due		
Cash	0.277***	0.376***	0.130***	0.104***	0.0484***
	(0.0153)	(0.0135)	(0.0176)	(0.0168)	(0.0133)
Loss	-0.104***	-0.0147	-0.0938***	-0.0792***	-0.0440***
	(0.0366)	(0.0278)	(0.0259)	(0.0223)	(0.0112)
*Cash*Loss*	-0.0232	-0.149***	0.102***	0.119***	0.0821***
	(0.0153)	(0.0135)	(0.0176)	(0.0168)	(0.0133)
Control Variables	Yes	Yes	Yes	Yes	Yes
Year & Firm FE	Yes	Yes	Yes	Yes	Yes
Observations	16,231	13,181	12,456	11,146	9,652
R^2	0.414	0.561	0.602	0.629	0.529
			Panel C p-values		
Cash	0.344	0.0301	0.0275	0.0919	0.0172
Loss	0.570	0.6504	0.3446	0.151	0.175
*Cash*Loss*	0.984	0.910	0.340	0.590	0.560

Table 1-9 Investment-Cash Holding Sensitivities and Operation Loss: Corporate Governance

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by corporate governance. Firms are partitioned into good (*Good Governance*) and poor governance (*Poor Governance*) groups by insider ownership. The dependent variable is *Investment* (*capx + aqc + xrd*)/(*at - che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Column 1 reports the estimation of firms with good governance. Column 2 reports the estimation of firms with poor governance. Colum 3 reports the *p*-values for the difference in coefficients of *Cash*, *Loss* and *Cash*Loss* between firms with good and poor governance. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
Investment (*Dependent Var.*)	*Good Governance*	*Poor Governance*	*p-values*
Cash	0.154***	0.151***	0.241
	(0.0379)	(0.0465)	
Loss	-0.487**	-0.426*	0.691
	(0.206)	(0.236)	
*Cash*Loss*	0.239***	0.0967**	0.928
	(0.0380)	(0.0464)	
Control Variables	Yes	Yes	
Year & Firm Fixed Effects	Yes	Yes	
Observations	8564	6001	
R^2	0.475	0.301	

Table 1-10 Investment-Cash Holding Sensitivities and Operation Loss: Geographical Diversification

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss based on subsamples grouped by whether firms are multinational firms. Firms are partitioned into domestic (*Domestic*) and multinational (*Multinational*) groups by whether they report foreign incomes (*pifo*). The dependent variable is *Investment* (*capx + aqc + xrd*)/(*at - che*). The independent variables are *Cash* (*che/(at - che)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Column 1 reports the estimation of domestic firms. Column 2 reports the estimation of multinational firms. Colum 3 reports the *p*-values for the difference in coefficients of *Cash*, *Loss* and *Cash*Loss* between domestic and multinational firms. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
Investment (*Dependent Var.*)	*Domestic*	*Multinational*	*p-values*
Cash	0.160***	0.161***	0.0226
	(0.0166)	(0.0192)	
Loss	0.0462	-0.337***	0.0449
	(0.105)	(0.0913)	
*Cash*Loss*	-0.0625***	0.150***	0.458
	(0.0165)	(0.0192)	
Control Variables	Yes	Yes	
Year & Firm Fixed Effects	Yes	Yes	
Observations	3796	22,315	
R^2	0.451	0.370	

Table 1-11 Endogeneity: Instrumental Variable

This table reports the regression estimation of investment sensitivities to cash holdings with and without operation loss from a 2SLS framework. The dependent variable in the column 2 is *Cash* (*che/(at - che)*). The independent variables in the column 2 are *Tangibility (ln(ppent))* and lagged cash holdings. Column 2 reports the estimation of the first stage regression where cash holdings are instrumented by asset tangibility. The dependent variable in the column 1 is *Investment* (*capx + aqc + xrd*)/(*at - che*). The independent variables in the column 1 are instrumented *Cash (obtained in the first stage)*) and *Loss* (*=1 if oancf < 0, = 0 otherwise*). Column 1 reports the main estimation. All regressions include year and firm fixed effects. For brevity, control variables are not presented in this table. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)
Investment (*Dependent Var.*)	*Full Sample*	*First Stage*
Cash (Instrumented)	0.448***	
	(0.0268)	
Loss	-0.390***	
	(0.0881)	
*Cash (Instrumented)*Loss*	0.164***	
	(0.0253)	
Tangibility		-1.554***
		(0.0777)
$Cash_{t-1}$		0.220***
		(0.0367)
$Cash_{t-2}$		0.147***
		(0.0364)
Control Variables	Yes	Yes
Year & Firm Fixed Effects	Yes	Yes
Observations	20,515	20,515
R^2	0.538	0.603

Table 1-12 Definitions of Variables in Chapter 1

Cash	Firm cash holdings (*che / (at - che)*).
Cash Flows	Firm cash flows (*(ibc + dp) / at*).
Dividend	Firm total dividend payment indicator (*equals 1 if dvt > 0, 0 otherwise*).
ICFV	Industry cash flow volatility (*equals the standard deviation of industry cash flow*).
Investment	Corporate investments (*(capx + xrd + aqc) / (at - che)*).
Leverage	Firm leverage (*(dltt + dlc) / (dltt + dlc + csho * prcc_f)*).
Loss	Operation loss indicator (*equals 1 if oancf < 0, 0 otherwise*).
NWC	Firm net working capital (*(act – lct - che) / at*).
Q	Tobin's Q (*(at + (csho * prccf) - ceq) / at*).
Size	Firm size, natural logarithm of firm total assets (*ln(at)*).
Tangibility	Asset tangibility, natural logarithm of firm property, plant, and equipment (*ln(ppent)*).

Appendix B

2. Appendix B

The Appendix B lists the tables from Chapter 2.

Table 2-1 Descriptive Statistics

This table reports the summary statistics for the key variables. The sample is constructed based on CRSP/Compustat firms. The sample date ranges from January 1990 to December 2019. $X_{i,t}$ equals the value of X at time t, $dX_{i,t}$ is the difference of $X_{i,t} - X_{i,t-1}$, $dX_{i,t+1}$ represents the difference of $X_{i,t+1} - X_{i,t}$. *Cash* is cash and cash equivalents (*ch*), *FinancialAssets* is short-term investments (*ivst*), and *TotalCash* is total cash holdings (*che*). *V* is the market value of firms (*prcc_f* * *csho* + *dlc* + *dltt*). *E* is earnings before extraordinary items (*ib* + *xint* + *txdi* + *itc*). *NA* is net cash positions (*at* - *che*). *RD* is R&D expenses, missing values are set to zero. *I* indicates interest expenses (*xint*), and *D* is cash dividend (*dvc*). All variables are deflated by total assets (*at*).

	(1) *Mean*	(2) *Std. Dev*	(3) *Min*	(4) *Max*	(5) *Observations*
Cash	0.129	0.158	-0.00584	0.995	23,020
FinancialAssets	0.0472	0.118	0	0.983	23,020
TotalCash	0.177	0.206	-0.00161	1	23,020
V	1.804	2.903	0.00448	208.4	23,020
dV_{t+1}	0.273	2.238	-109.1	97.05	23,020
E	-0.00534	0.383	-28.45	2.223	23,020
dE	0.0148	0.566	-6.191	62.33	23,020
dE_{t+1}	0.0136	0.377	-28.44	29.45	23,020
dNA	0.0367	0.398	-37.31	0.971	23,020
dNA_{t+1}	0.102	0.566	-0.999	44.06	23,020
RD	0.0454	0.158	-0.00393	7.825	23,020
dRD	0.000254	0.135	-11.44	5.239	23,020
dRD_{t+1}	0.00129	0.0839	-7.490	1.472	23,020
I	0.0176	0.0681	-0.00431	6.774	23,020
dI	-0.000270	0.128	-18.42	2.070	23,020
dI_{t+1}	0.00158	0.0744	-6.646	6.428	23,020
D	0.0146	0.0399	-0.00726	1.458	23,020
dD	0.000484	0.0423	-1.767	1.458	23,020
dD_{t+1}	0.00124	0.0580	-1.458	6.701	23,020

Table 2-2 The Value of Non-cash Cash Holdings: Baseline Regressions

This table reports the regression estimation of the value of cash holdings. The dependent variable of all regressions is the market value of firm *V* (*prcc_f* * *csho* + *dlc* + *dltt*). The key independent variables are cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*) in column 1, total cash holdings *TotalCash* (*che*) in column 2. All variables are deflated by total assets (*at*). Column 1 reports the value of cash and short-term investments at mean level. Column 2 reports the value of total cash holdings at mean level. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)
V (*Dependent Var.*)	*Cash & FinancialAssets*	*Total Cash Holdings*
Cash	1.557***	
	(0.130)	
FinancialAssets	1.016***	
	(0.164)	
TotalCash		1.372***
		(0.114)
E	0.909***	0.906***
	(0.0730)	(0.0730)
dE	0.411***	0.416***
	(0.0350)	(0.0350)
dE_{t+1}	0.445***	0.448***
	(0.0490)	(0.0490)
dNA	0.126***	0.124***
	(0.0306)	(0.0306)
dNA_{t+1}	0.351***	0.352***
	(0.0209)	(0.0209)
RD	16.52***	16.54***
	(0.189)	(0.188)
dRD	-1.700***	-1.687***
	(0.144)	(0.144)
dRD_{t+1}	16.34***	16.35***
	(0.233)	(0.233)
I	0.794***	0.800***
	(0.216)	(0.216)
dI	-0.992***	-0.980***
	(0.0975)	(0.0974)
dI_{t+1}	2.053***	2.051***
	(0.171)	(0.171)
D	3.768***	3.768***
	(0.483)	(0.484)
dD	-1.722***	-1.698***
	(0.326)	(0.326)
dD_{t+1}	0.857***	0.859***
	(0.257)	(0.257)
V_{t+1}	-0.197***	-0.197***
	(0.00600)	(0.00600)
Year	-0.00706***	-0.00665***
	(0.00194)	(0.00194)
Firm Fixed Effects	Yes	Yes
Observations	23,020	23,020
R^2	0.385	0.385

Table 2-3 The Value of Non-cash Cash Holdings: Debt Retirement

This table reports the regression estimation of the value of cash holdings based on subsamples grouped by whether firms have debt retirement status. Debt repayments is measured by whether firms have debt due in the next five years (*dd1, dd2… dd5*). The dependent variable of all regressions is the market value of firm *V* (*prcc_f* * *csho* + *dlc* + *dltt*). The key independent variables are cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*). All variables are deflated by total assets (*at*). *Panel A* reports the estimation of firms with no debt payment due. *Panel B* reports the estimation of firms with debt payments due. *Panel C* reports the *p*-values of the difference in the coefficients of *Cash* and *FinancialAssets* between firms with and without debt in each year. For brevity, only the variables of interest are presented. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)
V (*Dependent Var.*)	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
			Panel A No Debt Due		
Cash	2.402***	2.585***	1.849***	2.009***	1.617***
	(0.271)	(0.279)	(0.299)	(0.267)	(0.250)
FinancialAssets	1.899***	1.891***	1.519***	1.446***	1.049***
	(0.320)	(0.327)	(0.357)	(0.322)	(0.301)
Year	-0.00777	-0.0125*	-0.0140**	-0.0151**	-0.0133**
	(0.00603)	(0.00657)	(0.00704)	(0.00611)	(0.00545)
Control Variables	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	6868	6602	7051	8116	9055
R^2	0.363	0.350	0.478	0.475	0.464
			Panel B With Debt Due		
Cash	0.950***	1.046***	1.261***	0.968***	1.129***
	(0.154)	(0.155)	(0.119)	(0.124)	(0.125)
FinancialAssets	0.0205	-0.604***	-0.0408	0.718***	1.063***
	(0.213)	(0.219)	(0.170)	(0.178)	(0.182)
Year	-0.00460**	0.00146	-0.00392***	-0.00158	-0.00183
	(0.00182)	(0.00173)	(0.00128)	(0.00126)	(0.00122)
Control Variables	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	15,722	13,474	12,895	11,914	10,681
R^2	0.503	0.630	0.392	0.195	0.150
			Panel C p-values		
Cash	0.000	0.000	0.293	0.771	0.559
FinancialAssets	0.000	0.000	0.329	0.976	0.0909

Table 2-4 The Value of Non-cash Cash Holdings: Short-term Liquidity Needs

This table reports the regression estimation of the value of cash holdings based on subsamples grouped by short-term liquidity needs. Liquidity needs is measured by market-to-book ratio (*at − ceq + (prcc_f * csho))/at*). The dependent variable of all regressions is the market value of firm *V* (*prcc_f * csho + dlc + dltt*). The key independent variables are cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*). All variables are deflated by total assets (*at*). Column 1 reports the value of cash and short-term investments for low liquidity needs firms. Column 2 reports the value of cash and short-term investments for high liquidity needs firms. Column 3 reports the *p*-values of difference in coefficients of *Cash* and *FinancialAssets* between firms with low and high liquidity needs. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
V (*Dependent Var.*)	*Low Liquidity Needs*	*High Liquidity Needs*	*p-values*
Cash	0.235***	1.782***	0.000
	(0.0298)	(0.239)	
FinancialAssets	0.293***	1.240***	0.420
	(0.0392)	(0.288)	
E	0.440***	1.282***	
	(0.0269)	(0.120)	
dE	-0.0372***	0.262***	
	(0.0128)	(0.0558)	
dE_{t+1}	0.289***	0.452***	
	(0.0199)	(0.0757)	
dNA	0.0945***	0.278***	
	(0.0114)	(0.0524)	
dNA_{t+1}	0.0456***	0.528***	
	(0.00438)	(0.0412)	
RD	0.485***	18.26***	
	(0.125)	(0.286)	
dRD	-0.0519	-2.725***	
	(0.0542)	(0.227)	
dRD_{t+1}	0.589***	17.80***	
	(0.134)	(0.346)	
I	0.426**	1.571***	
	(0.189)	(0.348)	
dI	-0.440***	-1.131***	
	(0.129)	(0.136)	
dI_{t+1}	0.210***	3.583***	
	(0.0360)	(0.334)	
D	1.047***	3.719***	
	(0.146)	(0.806)	
dD	-0.200**	-1.903***	
	(0.0886)	(0.523)	
dD_{t+1}	0.588***	0.486	
	(0.101)	(0.379)	
dV_{t+1}	-0.0516***	-0.208***	
	(0.00385)	(0.00850)	
Year	0.00266***	-0.00821**	
	(0.000395)	(0.00406)	
Firm Fixed Effects	Yes	Yes	
Observations	11,528	11,481	
R^2	0.101	0.437	

Table 2-5 The Value of Non-cash Cash Holdings: Financial Constraints

This table reports the regression estimation of the value of cash holdings based on subsamples grouped by financial constraints. The financial constraint criterion is *SA index*. The dependent variable of all regressions is the market value of firm *V* (*prcc_f* * *csho* + *dlc* + *dltt*). The key independent variables are cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*). All variables are deflated by total assets (*at*). Column 1 reports the value of cash and short-term investments for constrained firms. Column 2 reports the value of cash and short-term investments for unconstrained firms. Column 3 reports the *p*-values of difference in coefficients of *Cash* and *FinancialAssets* between financially constrained and unconstrained firms. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

V (*Dependent Var.*)	(1) *Constrained*	(2) *Unconstrained*	(3) *p-values*
Cash	2.688***	0.450**	0.000
	(0.304)	(0.203)	
FinancialAssets	2.320***	1.274***	0.0961
	(0.381)	(0.246)	
E	-0.300**	4.713***	
	(0.137)	(0.217)	
dE	0.360***	-0.583***	
	(0.0641)	(0.122)	
dE_{t+1}	-0.173**	2.842***	
	(0.0868)	(0.134)	
dNA	0.307***	0.166*	
	(0.0572)	(0.0869)	
dNA_{t+1}	0.309***	0.253***	
	(0.0576)	(0.0459)	
RD	15.04***	6.023***	
	(0.366)	(0.725)	
dRD	-0.225	1.919**	
	(0.280)	(0.918)	
dRD_{t+1}	13.28***	10.32***	
	(0.449)	(0.638)	
I	3.354***	-2.850**	
	(0.997)	(1.376)	
dI	-2.663***	1.148	
	(0.800)	(1.750)	
dI_{t+1}	-0.470	0.836	
	(0.305)	(1.624)	
D	1.167	5.391***	
	(1.618)	(0.669)	
dD	-0.965	-2.316***	
	(0.861)	(0.374)	
dD_{t+1}	1.954*	1.335***	
	(1.101)	(0.392)	
dV_{t+1}	-0.191***	-0.102***	
	(0.0118)	(0.00988)	
Year	-0.0384***	0.00259	
	(0.00876)	(0.00240)	
Firm Fixed Effects	Yes	Yes	
Observations	5,866	5,918	
R^2	0.384	0.211	

Table 2-6 The Value of Non-cash Cash Holdings: Corporate Governance

This table reports the regression estimation of the value of cash holdings based on subsamples grouped by corporate governance. Corporate governance is measured by levels of insider ownership. The dependent variable of all regressions is the market value of firm *V* (*prcc_f* * *csho* + *dlc* + *dltt*). The key independent variables are cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*). All variables are deflated by total assets (*at*). Column 1 reports the value of cash and short-term investments for poorly governed firms. Column 2 reports the value of cash and short-term investments for well governed firms. Column 3 reports the *p*-values of difference in coefficients of *Cash* and *FinancialAssets* between poorly governed and well governed firms. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
V (*Dependent Var.*)	*Poorly Governed*	*Well Governed*	*p-values*
Cash	1.031***	2.175***	0.000
	(0.225)	(0.291)	
FinancialAssets	1.215***	-0.0812	0.000
	(0.277)	(0.419)	
E	-0.0236	0.607***	
	(0.144)	(0.148)	
dE	-0.0128	0.493***	
	(0.0604)	(0.0581)	
dE_{t+1}	0.118	0.874***	
	(0.0948)	(0.113)	
dNA	-0.0655	0.132***	
	(0.0772)	(0.0376)	
dNA_{t+1}	0.0666***	0.467***	
	(0.0203)	(0.0427)	
RD	6.162***	16.29***	
	(0.342)	(0.383)	
dRD	-0.288	-3.749***	
	(0.256)	(0.291)	
dRD_{t+1}	5.416***	5.948***	
	(0.307)	(0.528)	
I	6.110***	-6.391***	
	(0.626)	(1.294)	
dI	-2.386***	1.357	
	(0.450)	(0.905)	
dI_{t+1}	2.860***	-3.924***	
	(0.318)	(1.111)	
D	3.381***	4.603***	
	(0.708)	(1.256)	
dD	-1.820***	-1.840***	
	(0.530)	(0.680)	
dD_{t+1}	-0.0502	1.498*	
	(0.189)	(0.772)	
dV_{t+1}	-0.254***	-0.365***	
	(0.0109)	(0.0156)	
Year	0.00956	0.0174*	
	(0.00653)	(0.0103)	
Firm Fixed Effects	Yes	Yes	
Observations	4738	4722	
R^2	0.257	0.481	

Table 2-7 The Value of Non-cash Cash Holdings: The Value of Investments

This table reports the regression estimation of the value of corporate investments. The tests use the same baseline model (4) but has a focus on the variable *dNA*. Following Kyröläinen et al. (2013), investments is measured by changes in non-cash assets *dNA*. The dependent variable of all regressions is the market value of firm *V* (*prcc_f * csho + dlc + dltt*). The key independent variable is investment *dNA* (*at - che*). Other key independent variables include two cash holding variables, cash *Cash* (*ch*) and short-term investments *FinancialAssets* (*ivst*); two cash holding ratio variables, cash ratio *Cash Ratio* (*ch/che*), short-term investments ratio *FinancialAssets Ratio* (*ivst/che*), and an corporate governance variable, insider ownership *Insider*. All variables except the cash holding ratio variables and the governance variable are deflated by total assets (*at*). Column 1 reports the value of investments from regressions using raw cash holding items. Columns 2 reports the value of investments from regression using cash holding ratio items (*Casn Ratio*). Columns 3 report3 the value of investments from regression using cash holding ratio items (*FinancialAssets Ratio*). For brevity, only the variables of interest are presented. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)
V (*Dependent Var.*)	*Pooled*	*Cash*	*FinancialAssets*
Cash	1.830***	1.844***	1.822***
	(0.191)	(0.189)	(0.186)
FinancialAssets	0.887***	0.800***	0.796***
	(0.258)	(0.255)	(0.254)
dNA	0.325***	1.007***	0.127***
	(0.0739)	(0.255)	(0.0317)
*dNA*Cash*	-0.411**		
	(0.186)		
*dNA*FinancialAssets*	2.973***		
	(0.865)		
*dNA*Cash Ratio*		-0.827***	
		(0.274)	
*dNA*FinancialAssets Ratio*			1.278***
			(0.310)
*dNA*Cash*Insider*	0.000774		
	(0.00306)		
*dNA*FinancialAssets*Insider*	-0.0174		
	(0.0751)		
*dNA*Cash Ratio*Insider*		-0.00101	
		(0.00142)	
*dNA*FinancialAssets Ratio*Insider*			-0.0418**
			(0.0189)
dNA_{t+1}	0.218***	0.216***	0.214***
	(0.0219)	(0.0219)	(0.0219)
Insider	0.00141	0.00118	0.00107
	(0.00301)	(0.00302)	(0.00302)
Year	0.0146**	0.0142**	0.0137**
	(0.00610)	(0.00611)	(0.00611)
Control Variables	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes
Observations	9460	9447	9447
R^2	0.352	0.350	0.351

Table 2-8 Robustness: Full Sample

This table reports the robustness regression estimation of the value of cash holdings. This table repeats the baseline tests by using the alternative approach developed by M. Faulkender and Wang (2006). For all regressions, the dependent variable is the firm excess return, which is the difference between firm-specific return and benchmark return of Fama and French 25 portfolios formed on size and book-to-market ratio. The key independent variables are the changes in cash *ΔCash* (*ch*) and changes in short-term investments *ΔFinancialAssets* (*ivst*). Column 1 reports the value of cash and short-term investments at mean level. All regressions include firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)
Excess Return (*Dependent Var.*)	*Full Sample*
ΔCash	1.580***
	(0.116)
ΔFinancialAssets	1.704***
	(0.220)
ΔE	0.172***
	(0.0301)
ΔNA	-0.0290
	(0.0308)
ΔRD	3.215***
	(0.268)
ΔI	-0.541**
	(0.269)
ΔD	-0.508
	(0.373)
$Cash_{t-1}$	0.471***
	(0.0761)
$FinancialAssets_{t-1}$	0.385**
	(0.157)
Leverage	-1.748***
	(0.139)
NF	0.475***
	(0.0645)
$Cash_{t-1}$*ΔCash	-0.127***
	(0.0361)
*Leverage*ΔCash*	2.766***
	(0.267)
$FinancialAssets_{t-1}$*ΔFinancialAssets	0.139**
	(0.0546)
*Leverage*ΔFinancialAssets*	-3.651***
	(0.437)
Year	0.0112***
	(0.00293)
Firm Fixed Effects	Yes
Observations	13,049
R^2	0.107

Table 2-9 Robustness: Liquidity Needs, Corporate Governance, and Financial Constraints

This table reports the robustness regression estimation of the value of cash holdings. This table repeats the baseline tests by using the alternative approach developed by M. Faulkender and Wang (2006). The sample is grouped by liquidity needs, corporate governance and financial constraints respectively. For all regressions, the dependent variable is the firm excess return, which is the difference between firm-specific return and benchmark return of Fama and French 25 portfolios formed on size and book-to-market ratio. The key independent variables are the changes in cash *ΔCash* (*ch*) and changes in short-term investments *ΔFinancialAssets* (*ivst*). Columns 1 and 2 report the value of cash and short-term investments based on subsamples grouped by liquidity needs (M/B ratio). Columns 3 and 4 report the value of cash and short-term investments based on subsample grouped by corporate governance. Columns 5 and 6 report the value of cash and short-term investments based on the subsamples grouped by financial constraints (SA index). All regressions include firms fixed effects. For brevity, only the variables of interest are presented. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)
Excess Return (*Dependent Var.*)	*Low Liquidity Needs*	*High Liquidity Needs*	*Poorly Governed*	*Well Governed*	*Constrained*	*Unconstrained*
ΔCash	0.0860	3.220***	1.812***	0.803***	-1.238***	1.909***
	(0.185)	(0.233)	(0.138)	(0.234)	(0.335)	(0.154)
ΔFinancialAssets	2.177***	1.702***	2.492***	0.252	2.527***	2.501***
	(0.302)	(0.355)	(0.219)	(0.305)	(0.475)	(0.232)
$Cash_{t-1}$*ΔCash*	0.0342	-0.643***	0.684***	-0.0710	1.180***	0.0928
	(0.0470)	(0.0941)	(0.106)	(0.237)	(0.128)	(0.136)
*Leverage*ΔCash*	3.217***	4.346***	-2.879***	0.148	6.579***	-0.771**
	(0.397)	(0.628)	(0.330)	(0.549)	(0.601)	(0.336)
$FinancialAssets_{t-1}$	0.179***	1.554*	0.101	-0.0467	0.236*	0.00138
ΔFinancialAssets	(0.0612)	(0.839)	(0.245)	(0.238)	(0.123)	(0.189)
Leverage	-4.517***	-6.594***	-3.448***	-0.489	-7.858***	-3.123***
ΔFinancialAssets	(0.536)	(1.358)	(0.614)	(0.718)	(1.102)	(0.497)
Year	0.0182***	0.00805**	0.0105*	0.0190*	0.0350**	-0.00532***
	(0.00471)	(0.00340)	(0.00629)	(0.0106)	(0.0139)	(0.00206)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	6601	6545	3133	3127	3579	3591
R^2	0.116	0.247	0.376	0.120	0.202	0.324

Table 2-10 Robustness: Debt Retirement

This table reports the robustness regression estimation of the value of cash holdings. This table repeats the baseline tests by using the alternative approach developed by M. Faulkender and Wang (2006). The sample is grouped by firm debt retirement status. For all regressions, the dependent variable is the firm excess return, which is the difference between firm-specific return and benchmark return of Fama and French 25 portfolios formed on size and book-to-market ratio. The key independent variables are the changes in cash *ΔCash* (*ch*) and changes in short-term investments *ΔFinancialAssets* (*ivst*). *Panel A* reports the value of cash and short-term investments for firms do not have long-term debt repayment due. *Panel B* reports the value of cash and short-term investments for firms have long-term debt repayment due. All regressions include firm fixed effects. For brevity, only the variables of interest are presented. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)
Excess Return (*Dependent Var.*)	*Year 1*	*Year 2*	*Year 3*	*Year 4*	*Year 5*
			Panel A No Debt Due		
ΔCash	2.571***	1.919***	0.322	-0.133	1.120***
	(0.312)	(0.270)	(0.253)	(0.232)	(0.185)
ΔFinancialAssets	-0.0890	0.664*	0.859**	0.326	0.674**
	(0.409)	(0.357)	(0.358)	(0.344)	(0.334)
$Cash_{t-1}$*ΔCash	-0.256**	-0.0334	0.633***	0.828***	0.214***
	(0.114)	(0.108)	(0.101)	(0.0956)	(0.0628)
*Leverage*ΔCash*	-3.636***	-5.421***	-0.128	1.497**	0.433
	(0.868)	(0.863)	(0.696)	(0.608)	(0.580)
$FinancialAssets_{t-1}$	4.111***	3.591***	3.097***	3.114***	3.069***
*ΔFinancialAssets	(0.263)	(0.236)	(0.240)	(0.239)	(0.243)
*Leverage*ΔFinancialAssets*	-7.246***	-11.42***	-9.792***	-10.11***	-10.02***
	(1.087)	(0.907)	(0.771)	(0.746)	(0.741)
Year	0.0225***	0.0205***	0.0251***	0.0195***	0.0270***
	(0.00698)	(0.00686)	(0.00707)	(0.00662)	(0.00640)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	3935	4128	4449	5085	5620
R^2	0.170	0.163	0.156	0.166	0.148
			Panel B With Debt Due		
ΔCash	0.765***	1.755***	1.565***	1.475***	1.401***
	(0.161)	(0.195)	(0.197)	(0.200)	(0.218)
ΔFinancialAssets	1.063***	1.114***	0.784**	0.728**	0.849**
	(0.318)	(0.324)	(0.343)	(0.343)	(0.374)
$Cash_{t-1}$*ΔCash	-0.274***	-0.613***	-0.662***	-0.651***	1.121***
	(0.0400)	(0.0399)	(0.0383)	(0.0373)	(0.155)
*Leverage*ΔCash*	4.952***	3.012***	3.215***	3.532***	0.524
	(0.341)	(0.382)	(0.379)	(0.371)	(0.453)
$FinancialAssets_{t-1}$	-0.00246	0.147**	-0.104*	-0.0588	-0.0719
*ΔFinancialAssets	(0.0608)	(0.0617)	(0.0614)	(0.0581)	(0.0572)
*Leverage*ΔFinancialAssets*	-2.573***	-3.075***	0.198	0.278	-0.0484
	(0.558)	(0.626)	(0.671)	(0.651)	(0.679)
Year	0.00550	0.00361	0.00444	0.00471	-0.000250
	(0.00338)	(0.00323)	(0.00309)	(0.00292)	(0.00280)
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes
Observations	9211	9018	8697	8061	7526
R^2	0.139	0.143	0.167	0.182	0.214

Table 2-11 Definitions of Variables in Chapter 2

Panel A Variables of the Main Model (Pinkowitz et al., 2006)

$Cash_{i, t}$	Firm cash and cash equivalents (*ch / at*).
$FinancialAssets_{i, t}$	Firm short-term investments (*ivst / at*).
$TotalCash_{i, t}$	Firm total cash holdings (*che / at*).
$V_{i, t}$	Firm market value (*((prcc_f * csho + dlc + dltt) / at*).
$dV_{i, t+1}$	Difference between current and lead firm market value.
$E_{i, t}$	Firm earnings before extraordinary items (*(ib + xint + txdi + itc) / at*).
$dE_{i, t}$	Difference between lagged and current firm earnings before extraordinary items.
$dE_{i, t+1}$	Difference between current and lead firm earnings before extraordinary items.
$dNA_{i, t}$	Difference between lagged and current firm net total assets (*(at – che) / at*).
$dNA_{i, t+1}$	Difference between current and lead firm net total assets.
$RD_{i, t}$	Firm R&D expenses (*xrd / at*).
$dRD_{i, t}$	Difference between lagged and current firm R&D expenses.
$dRD_{i, t+1}$	Difference between current and lead firm R&D expenses.
$I_{i,\,t}$	Firm interest expenses (*xint / at*).
$dI_{i, t}$	Difference between lagged and current firm interest expenses.
$dI_{i, t+1}$	Difference between current and lead firm interest expenses.
$D_{i, t}$	Firm cash dividends (*dvc / at*).
$dD_{i, t}$	Difference between lagged and current firm cash dividends.
$dD_{i, t+1}$	Difference between current and lead firm cash dividends.

Panel B Variables of Alternative model (M. Faulkender & Wang, 2006)

$r_{i, t}$	Firm stock returns.
$R_{i, t}$	Benchmark stock returns from French and Fama 25 portfolio on size and B/M
$Cash_{i, t}$	Firm cash and cash equivalents (*ch*).
$FinancialAssets_{i, t}$	Firm short-term investments (*ivst / at*).
$E_{i, t}$	Firm earnings before extraordinary items (*ib + xint + txdi + itc*).
$NA_{i, t}$	Firm net total assets (*at – che*).
$RD_{i, t}$	Firm R&D expenses (*xrd*).
$I_{i, t}$	Firm interest expenses (*xint*).
$D_{i, t}$	Firm cash dividends (*dvc*).
$NF_{i, t}$	Firm net financing (*sstk – prstkc + dltis – dltr*).
$L_{i, t}$	Firm leverage (*(dlc + dltt) / (prcc_f * csho + dlc + dltt)*).
$M_{I, t}$	Lagged firm equity market value (*prcc_f * cshpri*).

Table 2-12 Descriptions of Cash and Cash Equivalents and Short-term Investments

This table provides Compustat definitions and explanations for cash and cash equivalents (*ch*) and short-term investments (*ivst*).

Panel A Cash and cash equivalents, ch

ch represents any immediately negotiable medium of exchange, or any instruments normally accepted by banks for deposit and immediate credit to a customer's account. This item includes the following:

1 Bank and finance company receivables
2 Bank drafts
3 Bankers' acceptances
4 Cash on hand (including foreign currency)
5 Certificates of deposit included in cash by the company
6 Checks (cashier's or certified)
7 Demand certificates of deposit
8 Demand deposits
9 Letters of credit
10 Money orders

Panel B Short-term investments, ivst

ivst represents currently marketable investments as presented in the current asset section of the Balance Sheet. Such investments may be converted to cash within a relatively short period of time. This item includes the following:

1 Accrued interest included with short-term investments by the company
2 Cash in escrow
3 Cash segregated under federal and other regulations
4 Certificates of deposit included in short-term investments by the company
5 Certificates of deposit reported as a separate item in current assets
6 Commercial paper
7 Gas transmission companies' special deposits
8 Good faith and clearing house deposits for brokerage firms
9 Government and other marketable securities (including stocks and bonds) listed as short-term
10 Margin deposits on commodity futures contracts
11 Marketable securities
12 Money market fund
13 Real estate investment trusts' shares of beneficial interest
14 Repurchase agreements, when shown as a current asset
15 Restricted cash, when shown as a current asset
16 Time deposits and time certificates of deposit, savings accounts when shown as a current asset
17 Treasury bills listed as short-term

Appendix C

3. Appendix C

The Appendix C lists the tables from Chapter 3.

Table 3-1 Descriptive Statistics

This table reports the summary statistics for the key variables. The sample is constructed based on Compustat firms. The sample date ranges from January 1999 to December 2019. *Holder67* is an indicator variable equals one if the CEO is overconfident by following Malmendier and Tate (2005). *LM12* is the first measure of level of stock illiquidity by following W. Huang and Mazouz (2018), *Amihud* is the second measure of level of stock illiquidity. *Cash* is total cash holdings, measured by Compustat item *che* deflated by total assets *at*. *RiskyInvestments* is the sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). *Size* is firm size, natural logarithm of market capitalization (CRSP items *prc*shrout*). *Leverage* is firm leverage, the ratio to total debt to total assets. *Dividend* (dummy) is indicator variable, which equals one if *dvc* is above zero. *B/M* (*ceq/prcc_f*csho*) is book-to-market ratio that measures growth opportunity. *ROA* assets (*ebitda/at*) is return on assets-in-place measures firm performance and *Volatility* is yearly standard deviation of firm daily stock return.

	(1) *Mean*	(2) *Median*	(3) *Std. Dev.*	(4) *Observations*
Holder67	0.858	1	0.349	23,325
LM12	4.262	2.988	5.958	23,325
Amihud	0.0630	0.0272	0.203	23,325
RiskyInvestments	0.0511	0.0122	0.0957	23,325
Cash	0.145	0.0801	0.167	23,325
Size	14.77	14.64	1.678	23,325
Leverage	0.235	0.209	0.214	23,325
Dividend	0.611	1	0.487	23,325
B/M	0.483	0.424	2.206	23,325
ROA	0.118	0.117	0.132	23,325
Volatility	0.0247	0.0212	0.0143	23,325

Table 3-2 Univariate Comparison

This table reports the comparison of summary statistics between firms with and without overconfident CEOs. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	Overconfident CEOs (*N = 20,022*)			*Non-Overconfident CEOs* (*N = 3,303*)			*Difference in Mean*
	Mean	*Median*	*Std. Dev.*	*Mean*	*Median*	*Std. Dev.*	
LM12	3.765	2.008	5.175	7.272	4.016	8.821	3.507***
Amihud	0.0568	0.0251	0.194	0.101	0.0438	0.247	0.044***
RiskyInvestments	0.0518	0.0131	0.0944	0.0472	0.00748	0.103	-0.005***
Cash	0.151	0.0874	0.168	0.109	0.0474	0.162	-0.043***
Size	14.86	14.72	1.662	14.24	14.09	1.678	-0.626***
Leverage	0.232	0.203	0.213	0.256	0.243	0.214	0.024***
Dividend	0.599	1	0.490	0.684	1	0.465	0.085***
B/M	0.470	0.401	0.793	0.562	0.566	5.527	0.092**
ROA	0.122	0.120	0.129	0.0893	0.103	0.141	-0.033***
Volatility	0.0243	0.0208	0.0138	0.0271	0.0233	0.0164	0.003***

Table 3-3 The Impact of CEO Overconfidence on Stock Liquidity: Baseline Regressions

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity. The dependent variable is the level of stock illiquidity, *LM12* in column 1 and *Amihud* in column 2. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. Column 1 reports the impacts of CEO overconfidence on firm stock liquidity (*LM12*) at mean level. Column 2 reports the impacts of CEO overconfidence on firm stock liquidity (*Amihud*) at mean level. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)
	Full Sample	
	LM12	*Amihud*
Holder67	-1.513***	-0.0203***
	(0.129)	(0.00474)
Size	-3.411***	-0.0779***
	(0.0540)	(0.00198)
Leverage	0.280	-0.0202**
	(0.260)	(0.00952)
Dividend	0.269**	0.0131***
	(0.116)	(0.00425)
B/M	-0.0136	0.00105**
	(0.0131)	(0.000481)
ROA	0.227	0.0111
	(0.334)	(0.0122)
Volatility	-38.41***	2.243***
	(3.189)	(0.117)
Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
Observations	23,325	23,325
R^2	0.374	0.129

Table 3-4 The Impact of CEO Overconfidence on Stock Liquidity: Mechanisms

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity through the channel of investments and cash holdings. The dependent variable is the level of stock illiquidity, *LM12* in columns 1 and 3 and *Amihud* in columns 2 and 4. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). *Cash* is lagged firm total cash holdings (*che/at*). Columns 1 and 2 report the impacts of CEO overconfidence and investment policy on firm stock liquidity at mean level. Columns 3 and 4 report the impacts of CEO overconfidence, investment policy and cash policy on firm stock liquidity at mean level. All regressions include year and firm fixed effects. For brevity, only the variables of interest are presented. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
		Full Sample		
	LM12	*Amihud*	*LM12*	*Amihud*
Holder67	-0.909***	-0.0207***	-1.054***	-0.0320***
	(0.137)	(0.00508)	(0.153)	(0.00564)
*Holder67*RiskyInvestments$_{t-1}$*	-5.754***	-0.0729*	-6.384***	-0.115***
	(1.082)	(0.0401)	(1.106)	(0.0409)
*Holder67*Cash$_{t-1}$*			2.021**	0.147***
			(0.828)	(0.0307)
RiskyInvestments$_{t-1}$	5.440***	0.0576	5.921***	0.0944**
	(1.032)	(0.0382)	(1.054)	(0.0390)
Cash$_{t-1}$			-2.498***	-0.152***
			(0.833)	(0.0308)
Control Variables	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	21,651	21,651	21,651	21,651
R^2	0.311	0.132	0.312	0.133

Table 3-5 Robustness: CFO Overconfidence

This table reports the robustness regression estimation of the impact of CFO overconfidence on firm stock liquidity. The dependent variable is the level of stock illiquidity *LM12*. The key independent variable is *Holder67*, an indicator variable that equals one if the CFOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 reports the impacts of CFO overconfidence on firm stock liquidity at mean level. Columns 2 reports the impacts of CEO overconfidence and investment policy on firm stock liquidity at mean level. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)
LM12 (*Dependent Var.*)	*Full Sample*	
Holder67 (*CFO*)	-0.301	-0.228
	(0.230)	(0.252)
Holder67 (*CFO*)**RiskyInvestments*		-3.229**
		(1.352)
RiskyInvestments		3.401**
		(1.330)
Size	-3.506***	-3.250***
	(0.0537)	(0.0530)
Leverage	0.438*	0.246
	(0.260)	(0.251)
Dividend	0.333***	0.211*
	(0.116)	(0.112)
B/M	-0.0140	-0.0175
	(0.0132)	(0.0120)
ROA	0.127	0.184
	(0.335)	(0.330)
Volatility	-40.73***	-32.50***
	(3.193)	(3.115)
Year Fixed Effects	Yes	Yes
Firm Fixed Effects	Yes	Yes
Observations	23,325	21,651
R^2	0.370	0.308

Table 3-6 Robustness: CEO Age

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity by controlling CEO age. Firms are divided into two groups by CEO age median, firms with younger CEOs are in the bottom groups, otherwise in the top group. The dependent variable is the level of stock illiquidity *LM12*. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 and 2 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with younger overconfident CEOs. Columns 3 and 4 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with older overconfident CEOs. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
LM12 (*Dependent Var.*)	*Younger CEOs*		*Older CEOs*	
Holder67	-1.725***	-0.645***	-0.950***	-0.634***
	(0.196)	(0.213)	(0.199)	(0.209)
*Holder67*RiskyInvestments*		-8.189***		-4.127**
		(1.512)		(1.716)
RiskyInvestments		7.230***		4.654***
		(1.447)		(1.639)
Size	-3.731***	-3.491***	-3.070***	-2.854***
	(0.0772)	(0.0778)	(0.0890)	(0.0864)
Leverage	-0.308	-0.622*	0.554	0.528
	(0.372)	(0.367)	(0.407)	(0.388)
Dividend	0.268	0.228	0.186	0.0943
	(0.169)	(0.167)	(0.177)	(0.170)
B/M	-0.0213	-0.0283*	0.153*	0.248***
	(0.0146)	(0.0158)	(0.0916)	(0.0926)
ROA	0.337	0.505	0.299	-0.336
	(0.445)	(0.433)	(0.556)	(0.557)
Volatility	-48.90***	-42.11***	-26.12***	-16.30***
	(4.420)	(4.326)	(4.825)	(4.752)
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	12,335	11,355	12,335	10,052
R^2	0.366	0.305	0.354	0.309

Table 3-7 Robustness: Corporate Governance

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity by controlling corporate governance. Firms are divided into two groups by corporate governance, which is measured by E-Index by following Bebchuk et al. (2008). The dependent variable is the level of stock illiquidity *LM12*. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 and 2 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with poor governance. Columns 3 and 4 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with good governance. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
LM12 (*Dependent Var.*)	*Poor Governance*		*Good Governance*	
Holder67	-1.847***	-1.038***	-1.908***	-1.057***
	(0.238)	(0.250)	(0.307)	(0.319)
*Holder67*RiskyInvestments*		-5.308***		-7.602***
		(1.662)		(2.572)
RiskyInvestments		5.994***		5.257**
		(1.561)		(2.386)
Size	-4.114***	-3.848***	-3.941***	-3.575***
	(0.106)	(0.105)	(0.172)	(0.169)
Leverage	0.595	-0.0429	2.274***	2.014***
	(0.559)	(0.536)	(0.801)	(0.759)
Dividend (dummy)	0.629***	0.465**	0.208	0.225
	(0.220)	(0.209)	(0.317)	(0.298)
B/M	-0.0158	-0.0253*	0.549***	0.435***
	(0.0149)	(0.0136)	(0.143)	(0.129)
ROA	2.443***	2.647***	-2.496*	-3.266**
	(0.548)	(0.547)	(1.386)	(1.316)
Volatility	-27.42***	-21.31***	-99.84***	-94.76***
	(4.541)	(4.184)	(10.00)	(9.212)
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	9089	8155	4330	3872
R^2	0.411	0.357	0.512	0.467

Table 3-8 Endogeneity: Inside Information

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity by controlling inside information. Firms are divided into two groups by whether CEOs gain profits from their option holdings by following Malmendier and Tate (2005). The dependent variable is the level of stock illiquidity *LM12*. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 and 2 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with CEOs gain profits from option holdings. Columns 3 and 4 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with CEOs lose profits from option holdings. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
LM12 (*Dependent Var.*)	*Gain*		*Loss*	
Holder67	-1.659***	-0.779***	-0.977***	-0.586**
	(0.193)	(0.194)	(0.238)	(0.254)
*Holder67*RiskyInvestments*		-5.011***		-7.928***
		(1.481)		(1.812)
RiskyInvestments		4.733***		7.437***
		(1.406)		(1.716)
Size	-3.501***	-2.987***	-3.465***	-3.442***
	(0.0888)	(0.0846)	(0.0993)	(0.0993)
Leverage	0.339	-0.0127	0.226	0.215
	(0.434)	(0.391)	(0.447)	(0.448)
Dividend	0.472**	0.0463	0.478**	0.455**
	(0.195)	(0.178)	(0.202)	(0.202)
B/M	0.391***	0.721***	0.0916**	0.0877*
	(0.136)	(0.206)	(0.0464)	(0.0464)
ROA	0.841	1.483***	1.362**	1.570***
	(0.563)	(0.544)	(0.600)	(0.602)
Volatility	-42.58***	-31.10***	-42.50***	-43.41***
	(5.917)	(5.351)	(5.772)	(5.768)
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	10,489	8815	7423	7423
R^2	0.429	0.328	0.318	0.320

Table 3-9 Endogeneity: CEO Tenures

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity by controlling CEO tenures. Firms are filtered into three groups, in which CEOs with tenures less than 1, 3 and 5 years are excluded respectively. The dependent variable is the level of stock illiquidity *LM12*. The key independent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero. *RiskyInvestments* is the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 and 2 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with CEOs having a tenure at least 1 year. Columns 3 and 4 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with CEOs having a tenure at least 3 years. Columns 5 and 6 report the impacts of CEO overconfidence (and investment policy) on firm stock liquidity for firms with CEOs having a tenure at least 5 years. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)	(5)	(6)
LM12 (*Dependent Var.*)	*Tenure > 1 year*		*Tenure > 3 years*		*Tenure > 5 years*	
Holder67	-1.457***	-0.866***	-1.440***	-0.875***	-1.588***	-0.966***
	(0.130)	(0.137)	(0.134)	(0.141)	(0.146)	(0.151)
*Holder67*RiskyInvestments*		-5.692***		-5.937***		-6.689***
		(1.080)		(1.110)		(1.160)
RiskyInvestments		5.473***		5.389***		5.888***
		(1.030)		(1.058)		(1.103)
Size	-3.421***	-3.168***	-3.428***	-3.163***	-3.453***	-3.185***
	(0.0553)	(0.0544)	(0.0583)	(0.0574)	(0.0644)	(0.0627)
Leverage	0.352	0.200	0.315	0.160	0.452	0.162
	(0.265)	(0.255)	(0.274)	(0.263)	(0.311)	(0.297)
Dividend	0.247**	0.169	0.344***	0.271**	0.475***	0.390***
	(0.118)	(0.113)	(0.122)	(0.117)	(0.135)	(0.129)
B/M	-0.0148	-0.0187	-0.0127	-0.0162	0.123***	0.123***
	(0.0130)	(0.0118)	(0.0129)	(0.0117)	(0.0452)	(0.0409)
ROA	0.338	0.308	0.222	0.166	-0.331	-0.596
	(0.346)	(0.338)	(0.379)	(0.362)	(0.422)	(0.404)
Volatility	-35.77***	-27.93***	-36.56***	-28.74***	-35.63***	-30.00***
	(3.237)	(3.124)	(3.355)	(3.229)	(3.640)	(3.406)
Year Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Observations	22,360	20,773	20,710	19,254	18,350	17,046
R^2	0.377	0.314	0.382	0.318	0.384	0.323

Table 3-10 Endogeneity: Instrumental Variables

This table reports the regression estimation of the impact of CEO overconfidence on firm stock liquidity from a 2SLS framework. The dependent variable is *Holder67*, an indicator variable that equals one if the CEOs are overconfident, otherwise, it equals zero, in columns 2 and 4. The key independent variable is the odds that an overconfident candidate can be elected as next CEO (*Incidence*) by following Deshmukh et al. (2021) in columns 2 and 4. Columns 2 and 4 reports the estimation of the first stage regression where CEO overconfidence (*Holder67*) is instrumented by *Incidence*. The dependent variable is the level of stock illiquidity *LM12* in columns 1 and 3. The key independent variable is *RiskyInvestments*, the lagged sum of firm acquisitions (*aqc*) and R&D expenses (*xrd*) divided by firm total assets (*at*). Columns 1 and 3 reports the main estimation. All regressions include year and firm fixed effects. The values in parentheses are standard errors. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$.

	(1)	(2)	(3)	(4)
			Full Sample	
	LM12	*Holder67*	*LM12*	*Holder67*
Holder67 (*instrumented*)	-2.091***		-1.520***	
	(0.264)		(0.289)	
Holder67 (*instrumented*)**RiskyInvestments*			-4.357***	
			(1.551)	
RiskyInvestments			4.206***	
			(1.423)	
Incidence		0.630***		0.591***
		(0.00792)		(0.00840)
Control Variables	Yes	Yes	Yes	Yes
Year Fixed Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Observations	23,325	23,049	21,651	21,651
R^2	0.545	0.718	0.534	0.719

Table 3-11 Definitions of Variables in Chapter 3

Amihud	Price impact index.
B/M	Firm book-to-market ratio (*ceq / (prcc_f * csho)*).
Cash	Firm cash holdings (*che / at*).
Dividend	Firm cash dividend payment indicator (*equals 1 if dvc > 0, 0 otherwise*).
Holder67	CEO overconfidence indicator.
Leverage	Firm leverage (*(dltt + dlc) / at*).
LM12	Trading discontinuity index.
RiskyInvestments	Corporate risky investments (*(aqc + xrd) / at*).
ROA	Firm return on assets (*ebitda / at*).
Size	Firm size, natural logarithm of market capitalization (*ln(prc * shrout)*).
Volatility	Firm stock return volatility.

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