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Tomohito Honda, Hitotsubashi University

Iichiro Uesugi, Hitotsubashi University

RCESR

The Research Center for Economic and Social Risks
Institute of Economic Research
Hitotsubashi University

2-1 Naka, Kunitachi, Tokyo, 186-8603 JAPAN
http://risk.ier.hit-u.ac.jp/

COVID-19 and Precautionary Corporate Cash Holdings: Evidence from Japan[ab]

Tomohito Honda[c] and Iichiro Uesugi[d]

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Abstract

This study examines how listed firms have managed their cash holdings since the outbreak of the COVID-19 crisis, using quarterly data on publicly-traded firms in Japan. After providing an overview of developments in cash holdings since the start of the crisis, we focus on the precautionary motive for corporate cash holdings and examine the role of firms' cash flow and volatility therein in firms' cash holdings to find the following: (1) corporate cash holdings have increased rather than decreased since the start of the crisis; (2) an increase in firms' cash flow has a positive impact on their cash holdings during normal times, and the sensitivity of cash holdings to cash flows was more pronounced during the first three months of the crisis; (3) firms facing higher sales volatility held more cash in the second three-month period following the start of the crisis; and (4) the cash flow sensitivity of financially constrained firms' cash holdings during the crisis period increased more than that of unconstrained firms. Overall, the COVID-19 crisis has had a substantial impact on corporate cash management strategies and the results are consistent with the precautionary motive theory for cash holdings.

Keywords: Cash holdings; Precautionary motive; COVID-19
JEL classification codes: G31; G32

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[c] Corresponding author, Institute of Economic Research, Hitotsubashi University. Email: thshhonda@gmail.com.

[d] Institute of Economic Research, Hitotsubashi University. Email: iuesugi@ier.hit-u.ac.jp.

1. Introduction

Cash holdings play a critical role in corporate liquidity management and have been the focus of many previous studies. A number of researchers have studied the determinants of firms' cash holdings and have identified two major factors: the transaction motive and the precautionary motive.[1] The transaction motive refers to firms' desire to hold a sufficient amount of cash to pay for transactions without having to incur the cost of converting fixed assets into liquid ones. Meanwhile, the precautionary motive refers to the desire to hold sufficient cash for unexpected contingencies. Firms tend to hold substantial amounts of cash for unexpected funding demands (see, e.g., Almeida et al., 2004; Riddick and Whited, 2009; Duchin et al. 2010). Numerous studies examine situations in which the precautionary motive for cash holdings plays an important role. Opler et al. (1999), for example, argue that the precautionary motive becomes more important when firms' cash flow is subject to greater risk or firms have limited access to external financing. Similarly, modeling firms' demand for liquidity, Almeida et al. (2004) show that financially constrained firms are likely to save a larger amount of their cash flow for precautionary cash holdings than unconstrained firms.

The precautionary motive for corporate cash holdings becomes even more important during times of financial or economic crisis, such as the current crisis brought about by the COVID-19 pandemic. Several studies examine whether the propensity to build up precautionary cash reserves is greater during financial crises than during normal times and find that this is indeed the case. For instance, Sun and Wang (2015), focusing on the impact of the global financial crisis in 2008, find that the cash flow sensitivity of cash was significantly greater during the crisis period. Similarly, investigating the long-term effect of the Asian financial crisis on corporate cash holdings in eight East Asian countries, Song and Lee (2012) find that firms in these countries built up cash holdings

[1] In the literature on corporate finance, there are other motives such as the tax motive and the agency motive. See Bates et al. (2009), who describe these motives in more detail.

following the crisis by decreasing investment. They also show that firms' increased sensitivity to cash flow volatility was one of the main factors for their higher level of cash holdings. Meanwhile, examining the 2008 European financial crisis, Lozano and Yaman (2020) find that the crisis had a positive impact on corporate cash holdings for three years following the crisis. Further, investigating the link between cash flow volatility and cash holdings for constrained firms, they observe that the positive correlation was larger during the crisis than before the crisis.

While these studies focus on the impact of financial crises on corporate cash holdings, to the best of the authors' knowledge, there are no studies to date that examine the impact of the outbreak of the COVID-19 pandemic on precautionary corporate cash holdings.[2] The crisis triggered by the pandemic has several unique features that warrant further research on cash holdings. First, in contrast with periods of financial crisis in the past, the financial sector has remained quite stable since the emergence of the current crisis. For example, in Japan, credit spreads on corporate bonds, which had jumped during the global financial crisis, increased only marginally at the onset of the crisis and have leveled off since then (Bank of Japan, 2020: Chart II-2-11). Various policy measures introduced by the Japanese government and the central bank have contributed to the stability of the financial system thus far. Second, the shock to the real economy has been unprecedented not only in its sheer size but also in the way industries are affected. The initial drop in aggregate output in Japan, for example, was the largest in the past 70 years. Moreover, due to the nature of the shock, the damage was distributed unevenly across industries. Some industries, such as transportation, accommodations and restaurants, and services for individuals incurred massive losses due to the state of emergency declared by the Japanese government made people refrain from going out and eating out, while for other industries,

[2] While there are no studies so far focusing on the impact of the pandemic on precautionary cash holdings, there already are a considerable number of studies on the impact of the COVID-19 pandemic on various other aspects of corporate finance. For example, Francis et al. (2020) examine the impact on firms' capital structure across 31 countries, Acharya and Steffen (2020) examine firm financing through the corporate bond market and existing credit lines, Li et al. (2020) analyze firms' demand for bank liquidity and banks' capacity to supply the liquidity in the first four months of 2020, and De Vito and Gomez (2020) examine how the COVID-19 health crisis could affect the liquidity of listed firms across 26 countries.

such as construction, telecommunications, and business services, the damage was relatively minor.[3] Third, the degree of uncertainty in a variety of areas has risen sharply since the outbreak of the pandemic. For example, looking at various measures for economic uncertainty for Japan, we find that the macroeconomic uncertainty index and the economic policy uncertainty index have reached the highest value in two decades.[4] This increase in economic uncertainty potentially may have led to an increase in demand for precautionary corporate cash holdings.

Against this background, this study examines how the precautionary demand for cash has been affected by the outbreak of the pandemic by focusing on the period from January to June 2020. Given that the outbreak of COVID-19 and government restrictions to restrain it represent a massive external shock to the economy, the pandemic provides an excellent natural experiment to examine whether and how the precautionary motive affects corporate cash holdings.

For our analysis, we employ a sample of 1,773 listed Japanese firms for the period up to the end of the second quarter of 2020. Our observation period includes not only the quarter from April to June, when the economy was massively affected by the state of emergency declared by the government for about two months, but also the preceding quarter from January to March.[5] Using quarterly data allows us to identify in a timely manner how the shock affected corporate cash holdings.

We obtain the following four findings. First, corporate cash holdings have increased rather than decreased since the onset of the COVID-19 crisis. Second, an increase in firms' cash flow has a positive impact on their cash holdings during normal times, and this positive cash flow sensitivity of cash was more pronounced in January–March 2020. Third, firms facing higher sales volatility held more cash in April–June 2020. Fourth, the increase in the cash flow sensitivity of cash during the crisis

[3] See, for example, the result of the Bank of Japan's September 2020 Tankan Survey for the heterogeneous impact on business conditions across industries.
[4] Other uncertainty measures include the economic surprise index and the market volatility index. For developments in each of these indices, see Shinohara et al. (2020).
[5] The declaration asked people to refrain from going out, but it was not legally enforceable. In addition, the Japanese government required elementary school to close temporarily on February 27. See, e.g., Watanabe and Yabu (2020) for more details.

was larger for financially constrained firms.

Overall, our findings suggest that the precautionary motive is the primary cause for the increase in Japanese publicly traded firms' cash holdings during the COVID-19 crisis, and the increase in precautionary cash holdings is more pronounced for firms that are likely to be financially constrained. Our study differs from extant research on corporate cash holdings during times of crisis in that it focuses on the COVID-19 crisis, which differs substantially in nature from the financial crises involving an increase in firms' external financing costs that previous studies focus on. In contrast, the current crisis caused direct damage to the real economy rather than via the financial sector. Our findings show that despite the absence of a rise in external financing costs, a significant increase in corporate cash holdings can be observed, which is a novel finding in the literature.

The remainder of the study proceeds as follows. Section 2 provides a more detailed overview of the related literature and posits our empirical hypotheses. Section 3 then explains the data we use and our empirical approach. Next, Section 4 presents the results, while Section 5 offers concluding remarks.

2. Related Literature and Hypotheses

Previous research has highlighted four motives for firms to hold cash: the transaction motive, the tax motive, the agency motive, and the precautionary motive. Among these, the motive that has received the most research attention is the precautionary motive. Several studies provide theoretical models that explain the role of the precautionary motive for corporate cash holdings and present supportive empirical evidence. Studies on the precautionary motive for cash holdings can be divided into two broad strands, which differ in terms of the variables they employ to examine to what extent cash holding is precautionary.

The first strand of the literature focuses on the level of firms' cash flow. For instance, Almeida

et al. (2004) construct a model for the precautionary demand for cash and posit that financially constrained firms save cash out of their cash flow, while the cash savings of unconstrained firms should not be systematically related to cash flows. Almeida et al. (2004) regard firms' cash flow sensitivity of cash, that is, the propensity to save cash flow for cash, as an indicator of the extent to which firms are financially constrained and hence save for precautionary reasons. Estimating cash ratio equations, they find that the correlation between cash and cash flow is indeed positive. Another study focusing on firms' cash flow but employing a different theoretical setup from that of Almeida et al. (2004) is Acharya et al. (2007). Specifically, in their setup, firms have only a limited capacity to hedge future investment opportunities against income shortfalls. In their model, firms expecting a large number of investment opportunities are more likely to save cash from their cash flow than to reduce their current debt. In their empirical analysis based on this model, the coefficients on firms' cash flow are significantly positive, which is consistent with their theoretical prediction.

A number of studies have followed up on these studies employing the methodology introduced by Almeida et al. (2004) and Acharya et al. (2007). A notable example is the study by Sun and Wang (2015), who examine precautionary corporate savings during the 2008 global financial crisis to find that the cash flow sensitivity of cash was significantly larger during the crisis than normal times.

Based on these studies, we posit our empirical hypothesis for corporate cash holdings during the COVID-19 crisis. Specifically, we argue that firms' cash flow is an important determinant of their cash holdings in normal times, since firms require a precautionary cash buffer for their day-to-day activities. In addition, the COVID-19 pandemic likely increased firms' desire for precautionary cash holdings. Our first empirical hypothesis, therefore, is as follows:

Hypothesis 1: The cash flow sensitivity of cash is positive in normal times and became more pronounced during the COVID-19 crisis.

The second strand of the literature focuses on the volatility of firms' cash flow as a determinant of precautionary cash holdings. In the literature, the volatility of a firm's cash flow is regarded as reflecting the degree of uncertainty regarding its future income and affects the amount of cash it holds. For instance, Opler et al. (1999) find that firms that face greater cash flow uncertainty hold a larger amount of cash than those with less uncertainty. Similarly, Han and Qiu (2007) theoretically show that financially constrained firms with higher cash flow volatility tend to hold a larger amount of cash for precautionary purposes. Bates et al. (2009) report that the average amount of cash held by firms in the US increased during the period 1980–2006 and conclude that the precautionary motive plays an important role in explaining the increase in the cash ratio. Finally, Riddick and Whited (2009) find that income uncertainty affects cash holdings more than do external finance constraints.

Among the follow-up studies employing the methodology introduced in this strand of the literature, several studies investigate the impact of financial crises on precautionary corporate cash holdings. For instance, Song and Lee (2012) investigate the long-term effect of the Asian financial crisis on corporate cash holdings in eight East Asian countries to show an increased sensitivity to cash flow volatility. They observe that this is one of the main factors explaining the higher level of firms' cash holdings after the crisis. Meanwhile, examining the 2008 European financial crisis, Lozano and Yaman (2020) find that for financially constrained firms the cash sensitivity to cash flow volatility was higher in the three years after the onset of the crisis than before the crisis.

Based on the above literature, we now posit our empirical hypothesis about the impact of firms' cash flow volatility on their cash holdings during the COVID-19 crisis. Specifically, we assume that firms' cash flow volatility is an important determinant of their cash holdings and that the crisis caused by the pandemic further increased the relevance of this determinant. Therefore, our second hypothesis regarding corporate cash holdings is as follows:

Hypothesis 2: There is a positive link between firms' cash flow volatility and their cash holdings in normal times, and this link became more pronounced during the COVID-19 crisis.

In the following section, we first describe the data and empirical strategy employed in our analysis and then examine the overall developments in firms' cash holdings before and since the outbreak of the pandemic, before empirically testing our hypotheses in Section 4.

3. Data and Empirical Strategy

3.1 Data and sample selection

For the analysis, we employ firm-level data from Nikkei NEEDS Financial QUEST provided by Nikkei Incorporated. Our sample comprises publicly-traded non-financial firms in Japan during the period March 2019–June 2020 and is limited to firms whose fiscal year ends in March. We drop firms that newly listed in 2020, leaving us with a final sample of 10,638 firm-quarter observations for 1,773 firms. All the variables used in our analysis are winsorized at the 1st and 99th percentiles to avoid problems caused by extreme outliers.

3.2 Empirical approach

To examine the two empirical hypotheses on the impact of cash flows and their volatility on cash holdings, we employ the following the conventional specification in the empirical literature on the determinants of cash holdings:

$$Y_{i,t} = \alpha + \beta_1 EBITDA_{i,t} + \beta_2 EBITDA_{i,t} * Crisis_t + \beta_3 Sales\ Volatility_{i,t} + \beta_4 Sales\ Volatility_{i,t} * Crisis_t + \boldsymbol{\beta X} + \delta_i + \varepsilon_{i,t} \quad (1)$$

As dependent variable $Y_{i,t}$ we employ four different variables. The first is $Cash$, which is defined as the sum of cash and deposits outstanding divided by book assets. The second, $Liquidity$, is calculated as the sum of cash, deposits, and marketable securities outstanding divided by book assets. The third, $\Delta Cash$, is defined as the quarter-on-quarter change in $Cash$. Finally, the fourth, $\Delta Liquidity$, is the quarter-on-quarter change in $Liquidity$.

Turning to the explanatory variables, $EBITDA$, a proxy of cash flow, is the ratio of earnings before interest, taxes, and depreciation and amortization to book assets. Based on Hypothesis 1, we expect the coefficient on $EBITDA$ to be positive. $Sales\ Volatility$ is the standard deviation of a firm's sales over the five years preceding the current period standardized by the average amount of assets during the same five years. The reason that we employ the standard deviation of sales rather than that of $EBITDA$ for cash flow volatility is that a firm's cash flow consists of sales and costs, and firms likely regard volatility in sales as more exogenous and difficult to control than volatility in costs. Hypothesis 2 expects that firms with higher sales volatility are likely to be more at risk of becoming financially distressed and therefore have a greater demand for precautionary cash holdings. We therefore expect the coefficient on $Sales\ Volatility$ to be positive as well. Next, $Crisis$ represents the period of the coronavirus crisis. Specifically, we use two dummies: $Crisis\ I$ is a dummy for the first quarter (January–March) of 2020, while $Crisis\ II$ is a dummy for the second quarter, i.e., April–June 2020. The purpose of using these two different dummies is to capture how Japanese firms' cash management changed in each of two periods.

We are also interested in the interaction terms between $EBITDA$ or $Sales\ Volatility$ and $Crisis$, since both hypotheses predict that the coefficients on $EBITDA$ and $Sales\ Volatility$ should be larger during the COVID-19 crisis. We therefore expect the coefficients on these interaction terms, i.e., $EBITDA \times Crisis$ and $Sales\ Volatility \times Crisis$, to be positive.

We add various other explanatory variables as controls. $Size$ is the natural logarithm of a firm's book assets. The larger firms are, the more easily they can access external finance, and the smaller their demand for cash will be due to the smaller information asymmetry between the firm and lenders. We therefore expect the coefficient on $Size$ to be negative. Next, Q is the ratio of a firm's market to book value of assets. Firms with more growth opportunities prefer cash to external finance because of the greater extent of information asymmetry for high growth firms. Consequently, we expect a positive coefficient on Q. Further, $Capex$ is the ratio of the sum of the quarterly change in tangible assets, depreciation, and amortization to the book value of assets. We expect the coefficient on $Capex$ to be negative because capital investment increases a firm's stock of collateralizable assets and enhances its debt capacity, which leads to a smaller demand for cash. Meanwhile, NWC is the ratio of net working capital to book assets, and we predict a negative coefficient because firms use working capital as an alternative source of cash. Finally, $Debt$ is the ratio of the sum of short- and long-term debt to book assets. Different theories yield different predictions, so the sign of the coefficient on $Debt$ could be positive or negative. On the one hand, theories suggesting that debt and cash act as substitutes in terms of firms' funding sources suggest that the sign should be negative (Opler et al. 1999, Kim et al. 1998, Bates et al. 2009). On the other hand, if firms are limited in their hedging capacity and debt and cash are imperfect substitutes, as suggested by the theoretical models in Acharya et al. (2007) and Guney et al. (2007), the sign will be positive.

3.3 Summary Statistics

In this subsection, we describe the characteristics of the variables that we employ in our analysis. We start with descriptive statistics, which are provided in Table 1.

(Insert Table 1)

The mean of $Cash$ is 0.200 and that of $Liquidity$ is 0.208, indicating that in Japan, firms'

cash holdings amount to about 20% of their total assets. This is above the average cash holding ratio of 16.8% reported by De Vito and Gomez (2020) for 26 mostly developed countries in 2018. The averages of $\Delta Cash$ and $\Delta Liquidity$ are identical at 0.004, indicating that the cash ratio and the liquidity ratio slightly increased during the period.

(Insert Table 2)

Next, we examine how the means of these variables differ across subperiods, that is, the period before and the period after the outbreak of the COVID-19 pandemic. Table 2 shows the means for various variables in each subperiod. We also test the statistical significance of differences between these subperiods. There are four notable findings. First, the cash and liquidity ratios increased significantly after the outbreak of the pandemic. *Cash* increased from 0.195 in the pre-crisis period to 0.202 in the first quarter of 2020 and 0.214 in the second quarter of 2020. *Liquidity* increased to a similar extent. The increase in these variables between the periods is statistically significant. Second, the growth in the cash and liquidity variables accelerated during the crisis period. While both $\Delta Cash$ and $\Delta Liquidity$ were around zero before the crisis, they increased to around 0.011 to 0.013 during the crisis. Third, due to the deterioration in business conditions during the crisis period, $EBITDA$, our measure of cash flow, decreased significantly after the outbreak of the crisis. While the profit rate was 0.021 before the crisis, it fell to 0.017 in the first quarter of 2020 and 0.011 in the second quarter of 2020. Fourth, there was little change in *Sales Volatility* after the start of the crisis. This is mostly due to the way we construct the variable, since we calculate the standard deviation of a firm's sales over the preceding five years.

Further, we examine detailed information on the distribution of differences in variables between periods. Specifically, for $Cash$, $Liquidity$, and $EBITDA$, we produce percentile statistics for the differences between $Crisis\ I$ or $Crisis\ II$ on the one hand and $Pre\ Crisis$ on the other. These statistics allow us to observe the share of firms that experienced a drop in their profitability and

the share of firms that saw an increase or decrease in their cash balance.

Table 3 shows the results. The distributions of $Cash$ and $Liquidity$ shift toward the right, indicating that these variables increased in the crisis period, while that of $EBITDA$ moves toward the left, meaning that firms' profitability substantially dropped during the crisis. The increase in the cash holding ratio and the decline in profitability became more pronounced as the crisis deepened from the first quarter to the second quarter of 2020. It should be noted that in the second quarter of 2020, the cash holding ratio of the majority of firms increased even though three-quarters of the firms experienced a decline in profitability.

(Insert Table 3)

To summarize, there was a substantial increase in corporate cash holdings during the first half of 2020, when the economy was affected by the COVID-19 shock and firms' profitability substantially dropped. Moreover, the increase in the average cash holding ratio was due not to an increase in the cash ratio of a small number of large firms but reflects an increase in the cash ratio for the majority of firms.

4. Results

In the summary statistics in the previous section, we observed an increase in corporate cash holdings and a decrease in cash flows in 2020 when the COVID-19 crisis unfolded. We also found that there was little change in sales volatility during the observation period. However, the descriptive statistics tell us little about the link between cash holdings and cash flows and, moreover, do not control for other factors. Therefore, in this section, we first present our estimation results controlling for other factors that are important determinants of cash holdings as well as firm fixed effects. Next, given that financial constraints have been highlighted as a key reason for precautionary cash holdings, we conduct various subsample analyses to examine how financial constraints affect corporate cash

holdings.

4.1 Baseline Results

Table 4 presents our baseline results on the determinants of cash holdings and changes therein. Columns (1) and (2) show the results when we employ the level of cash and liquid asset holdings as the dependent variable. There are several notable findings. First, the coefficients on $EBITDA$ are positive and significant. This result indicates that the cash flow sensitivity of cash is positive in normal times. Turning to the interaction terms between cash flow and the crisis dummies, the coefficient on the interaction term between $EBITDA$ and $Crisis\ I$ is positive and significant in column (2), while it is positive but insignificant in column (1). On the other hand, the coefficients on $EBITDA * Crisis\ II$ are insignificant in both columns. These results indicate that the cash flow sensitivity of cash was more pronounced at the onset of the crisis in the first quarter of 2020, but this was not necessarily the case later in the crisis (in the second quarter of 2020), when firms' cash flow declined substantially. A possible explanation for the insignificant coefficients on $EBITDA * Crisis\ II$ is that *EBITDA* declined substantially in the $Crisis\ II$ period, so that firms may not have been able to afford to save cash out of their cash flow.

(Insert Table 4)

Second, we find that the coefficients on $Sales\ Volatility$ in columns (1) and (2) are insignificant. This indicates that in normal times firms do not hoard cash in response to higher sales volatility. In contrast, the coefficients on the interaction terms between sales volatility and the crisis dummies turn significantly positive in the second quarter of 2020, i.e., a few months into the crisis, while this is not the case for the first quarter of 2020, the onset of the crisis. These results suggest that firms that faced higher sales volatility started to prepare for the liquidity shortage once they realized the substantial impact of the crisis and began to expect that it would last for a long time.

Third, the coefficients on the crisis dummies indicate that firms began to hoard more cash as the crisis deepened. The result in column (1) indicates that in the first quarter of 2020 firms' cash ratio was 0.5 percentage points higher than in the same quarter of 2019. The year-on-year increase was even larger in the second quarter, reaching 1.0 percentage point. In column (2), we find a similar pattern for the liquid asset ratio.

Fourth, there are several other control variables whose coefficients are statistically significant. $Capex$ has negative coefficients, presumably because capital investment increases firms' collateralizable assets and debt capacity, thus reducing the need for them to hold cash. NWC also has negative coefficients, which suggests that working capital substitutes for cash. The coefficients on $Debt$ are positive, indicating that cash and debt are imperfect substitutes, as predicted by Acharya et al. (2007).

Next, we turn to the results in columns (3) and (4), where we employ the changes in cash and liquid asset holdings as the dependent variable. While the results are by and large similar to those in columns (1) and (2), there are a few things to note. First, the coefficients on $EBITDA$ and its interaction terms with the crisis period dummies have generally the same sign as in columns (1) and (2), but some coefficients are more statistically significant. In particular, the coefficients on the interaction term between $EBITDA$ and $Crisis\ I$ are positive and significant in both columns (3) and (4). Second, the coefficients on the crisis dummies are positive and significant for the first quarter of 2020 but insignificant for the second quarter of 2020.

Overall, these results in Table 4 indicate that the increase in the cash ratio was larger at the onset of the crisis in the first quarter of 2020 and then leveled off in the second quarter of 2020, and the propensity to save cash out of cash flow was more pronounced during the crisis, which is consistent with our hypotheses.

4.2 Results for financially constrained firms

In this subsection, we conduct a set of subsample analyses and examine how financially constrained firms manage their cash holdings. As discussed in Section 2, previous theoretical studies on the precautionary motive for corporate cash holdings suggest that financially constrained firms are more likely to hoard precautionary cash than financially unconstrained firms.

Against this background, we expect the predictions of the two empirical hypotheses to apply more to financially constrained firms than to unconstrained ones. We therefore employ several variables to identify financially constrained firms, and by comparing them with unconstrained firms, we examine if financially constrained firms tended to save cash more during the crisis. The variables we use for defining constrained firms include firms' size, payout ratio, leverage, cash ratio, access to the bond market, and access to credit lines. Employing each of these variables in turn, we divide the total sample of firms into two groups (for example, small firms and large firms), define one group (small firms in this example) as financially constrained, and compare the estimation results with those for unconstrainted firms (large firms in this example). Note that in the analysis that follows, we limit the dependent variables to $Cash$ and $Liquidity$, that is, variables that represent levels rather than changes. The reason is that the baseline estimation results for the coefficients on $EBITDA$, $Sales\ Volatility$, and their interaction terms with the $Crisis$ dummies in Section 4.1 were qualitatively similar regardless of whether we used the dependent variables in levels or we used changes.

4.2.1 Small versus large firms

We start by using firms' asset size to identify financially constrained firms, based on Almeida et al. (2004) and Acharya et al.'s (2007) argument that the degree of firms' external financial frictions is related to their size. Specifically, we divide the sample into two groups based on the average amount

of book assets throughout the year 2019 (from the first to the fourth quarter of the year). We then regard firms with assets below the median as financially constrained and those with assets above the median as unconstrained.

(Insert Table 5)

Table 5 shows the results. The two columns under (A) are for small, constrained firms, while those under (B) are for large, unconstrained firms. The coefficients on $EBITDA$ in the $Cash$ and $Liquidity$ estimations are significantly positive only for small firms. Moreover, the coefficients on the interaction terms between $EBITDA$ and the $Crisis$ dummies are marginally significant in the $Liquidity$ estimation for small firms but insignificant in all the other estimations. In sum, we find a positive cash flow sensitivity of cash only for small firms. Moreover, the $Liquidity$ estimation for small firms suggests that the extent of the cash flow sensitivity of cash increased, albeit marginally, during the onset of the crisis in the first quarter of 2020.

Meanwhile, the results for $Sales\,Volatility$ show no substantial differences between small and large firms in the way their cash holdings responded to sales volatility not only during normal times but also during the crisis period. Specifically, for both small and large firms, the coefficients on $Sales\,Volatility$ and the interaction term between $Sales\,Volatility$ and *Crisis I* are insignificant, while those on the interaction term between $Sales\,Volatility$ and *Crisis II* have the same positive sign and are of a similar magnitude.

4.2.2 Low versus high payout firms

Next, based on Fazzari et al. (1988) and Almeida et al.'s (2004) argument that firms facing high external financing costs have an incentive to reserve cash instead of paying out cash flows to shareholders, we divide the sample into two groups based on firms' payout ratio (annual payouts/total assets) in March 2020. We then regard firms below the median as constrained and those above as

unconstrained.

(Insert Table 6)

Table 6 presents the results. They show that, on the one hand, the coefficients on $EBITDA$ are insignificant for low payout firms, while they are significant and positive for high payout firms. On the other hand, the coefficients on the interaction terms between $EBITDA$ and the $Crisis$ dummies are positive and significant for low payout firms, while they are insignificant for their high payout counterparts. The results imply that for constrained firms the cash flow sensitivity of cash was insignificant during normal times but became positive in the first quarter of 2020 and stayed positive in the second quarter of 2020. In contrast, for unconstrained firms, the cash flow sensitivity of cash was already positive in normal times and the pandemic did not significantly change this sensitivity. Thus, Hypothesis 1, which predicts a larger cash flow sensitivity of cash during the crisis period, applies more to low payout (constrained) firms than to firms with a high payout ratio (unconstrained firms).

Meanwhile, the results for $Sales\ Volatility$ show substantial differences between low and high payout firms. Specifically, while $Sales\ Volatility$ did not affect corporate cash holdings (i.e., $Cash$ and $Liquidity$) during normal times, the significant positive coefficient on the interaction term between $Sales\ Volatility$ and $Crisis\ II$ for low payout firms indicates that cash holdings did increase for constrained firms in the second quarter of 2020. This finding suggests that Hypothesis 2, which expects firms to respond more to volatility in their performance during a crisis than in normal times, holds for constrained firms but not for unconstrained ones.

4.2.3 Low versus high cash holding firms

Further, we use firms' amount of cash holdings to identify constrained firms, based on Duchin et al.'s (2010) finding that during the global financial crisis firms with low cash reserves reduced capital

investment more than firms with high cash reserves. Specifically, we divide the sample into two groups based on firms' average cash ratio from the first to the fourth quarter of 2019. We regard firms with an average cash ratio below the median as constrained and those above as unconstrained.

(Insert Table 7)

Table 7 reports the results. Similar to the results in Table 6, the coefficients on $EBITDA$ are insignificant but those on the interaction term between $EBITDA$ and $Crisis\,I$ are positive and significant for constrained firms. For unconstrained firms, the coefficients on $EBITDA$ are significant but those on the interaction terms are insignificant. Hence, Hypothesis 1 applies more to firms with a low cash ratio than those with a high cash ratio.

The results for $Sales\,Volatility$ show no substantial differences between low and high cash ratio firms in terms of how their cash holdings respond to sales volatility. That is, for firms in both subsamples, the coefficients on the interaction term between $Sales\,Volatility$ and $Crisis\,II$ are positive and significant. Note, however, that the size of the coefficients is somewhat larger for constrained than for unconstrained firms, suggesting that our Hypothesis 2 applies more to low than high cash ratio firms.

4.2.4 High versus low leverage firms

Next, we focus on firms' leverage. Highly levered firms are often regarded as financially constrained. This is due to the debt overhang problem, which means that firms loaded with a large amount of debt are unable to find new funding sources. We therefore divide the sample into two groups based on firms' leverage, which we define as the average ratio of a firm's book value of liabilities to the total assets from the first to the fourth quarter of 2019. We regard firms that are above the median leverage as constrained and those that are below the median as unconstrained.

(Insert Table 8)

Table 8 shows the results. Similar to the results in Tables 6 and 7, the coefficients on $EBITDA$ are insignificant for constrained firms, while they are significant for unconstrained firms. The coefficients on the interaction terms between $EBITDA$ and the $Crisis$ dummies are positive and significant for high leverage firms, while none of the coefficients on the interaction terms are significant for low leverage firms. Therefore, we can say that our Hypothesis 1 applies more to high leverage than low leverage firms.

However, the results for the interaction terms between $Sales\ Volatility$ and the $Crisis$ dummies are not in line with our hypothesis that the cash holdings of financially constrained firms were likely to have increased more during the crisis than those of unconstrained firms. Specifically, we find that the coefficients on $Sales\ Volatility * Crisis\ II$ are no larger for constrained firms than for unconstrained firms.

4.2.5 Firms without versus firms with access to the bond market

In addition, we follow the literature focusing on bond market access in order to identify financially constrained firms. Firms that have access to the bond market are more creditworthy and face lower external financing costs (Almeida et al., 2004; Acharya et al., 2007). In contrast, firms that do not have access to the bond market are unable to tap this important source for financing and consequently need to rely on banks for funding. We therefore regard these firms as firms without bond market access and consider them to be more financially constrained than firms that have access to the bond market. To identify whether firms have access to the bond market, we employ the method introduced in Iwaki (2019). Specifically, we look at corporate bond (CB) and corporate paper (CP) issuance records as well as firms' balance sheet information on CBs and CP outstanding spanning the period from 2000 to 2019. We regard firms that issued CBs or CP or had a non-zero amount of CBs or CP outstanding on their balance sheet at least once during the period as firms with access to the bond market. On the

other hand, we define firms that have not issued any bonds or CP as firms without access to the bond market.

(Insert Table 9)

Table 9 reports the estimation results for the two groups of firms. The coefficients on *EBITDA* are positive and significant in all estimations. In contrast, the coefficients on the interaction term between *EBITDA* and *Crisis I* are positive for firms without access to the bond market but not for those with. It can therefore be said that our Hypothesis 1 applies more to firms without access to the bond market than to firms with bond market access.

However, the results for the interaction terms between *Sales Volatility* and the *Crisis* dummies are not in line with our hypothesis that the cash holdings of financially constrained firms were likely to have increased more during the crisis than those of unconstrained firms. More specifically, the size of the coefficients on *Sales Volatility*Crisis II* for firms without access to the bond market is substantially smaller than that for firms with bond market access.

4.2.6 Firms that have access to credit lines and firms that do not

Finally, we focus on whether firms have access to credit lines and use this information to identify constrained firms. Studies examining firm financing during the 2007–2008 global financial crisis found that large firms in the United States massively drew down credit lines (e.g., Ivashina and Scharfstein, 2010). This underlines the importance of credit lines as a means for firms to access emergency funding during crisis times. In Japan, the use of credit lines has been on the rise since legal reforms at the end of the 1990s. Therefore, to take credit lines into account, we use information on credit lines as of the end of March 2020 to identify firms with credit lines, which we regard as unconstrained firms, and those without, which we regard as constrained firms.[6]

[6] Information on credit lines is taken from Nikkei NEEDS Financial QUEST. However, since some of the necessary

(Insert Table 10)

Table 10 shows the results for both groups of firms. For firms with no credit lines, the coefficients on *EBITDA* are positive and significant in the estimations, while for firms that have credit lines that they can draw down if necessary the coefficient is positive and significant in the estimation for *Cash* but insignificant in the estimation for *Liquidity.* Further, the coefficient on the interaction term between *EBITDA* and *Crisis II* is positive and significant for firms without credit lines in the *Liquidity* estimation but insignificant in all the other estimations. These results provide another piece of evidence that Hypothesis 1 applies more to firms that are more financially constrained than to less constrained firms. In contrast, the coefficients on the interaction terms between *Sales Volatility* and the *Crisis* dummies are insignificant in all estimations, meaning that these estimations do not provide any insights with regard to Hypothesis 2.

In the above analyses, we used various definitions for financially constrained firms and examined if our Hypotheses 1 and 2 apply more to such constrained firms than unconstrained firms. Hypothesis 1, which predicts a substantial increase in the cash flow sensitivity of cash during the crisis, holds more for constrained firms of all types than for their unconstrained counterparts. For Hypothesis 2, which predicts a substantial increase in the response of cash holdings to volatility in cash flows for constrained firms, our findings are less clear-cut. The hypothesis holds for some definitions of constrained firms (namely, firms with a low payout ratio and firms with a low cash ratio) but not for others.

5. Concluding Remarks

COVID-19 started spreading around the world at the beginning of 2020 and has caused severe damage

information is missing in the database, we supplement it with information from another database called "eol" provided by PRONEXUS Incorporated. Meanwhile, the reason we focus on information at year-end regarding firms' credit lines is that firms usually disclose credit line information on an annual rather than a quarterly basis.

to the Japanese economy. This study focused on the firm sector in Japan and examined how firms' cash holdings have been affected during the crisis. We found the following: (1) corporate cash holdings have increased rather than decreased since the onset of the crisis; (2) an increase in firms' cash flow had a positive impact on their cash holdings during normal times, and the positive cash flow sensitivity of cash was more pronounced during the first three months of the crisis; (3) firms facing higher sales volatility than other firms held more cash as the crisis unfolded; and (4) the increase in the cash flow sensitivity of cash during the crisis was larger for financially constrained firms.

Overall, the COVID-19 crisis has had a substantial impact on corporate cash management and the results are consistent with the precautionary motive theory for cash holdings. However, the present study only represents a first attempt at examining these issues using the COVID-19 crisis as an experiment. The observation period in our analysis covers only the first six months of 2020 and our sample consists only of listed firms. A task for the future, therefore, is to extend the observation period as more data become available and to expand the analysis to smaller, unlisted firms.

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Table 1: Descriptive statistics for the variables employed in the estimations

This table reports summary statistics for the sample. Definitions of variables are provided in Section 3.2. The unit for Size is million yen.

Variables	N	Mean	Sd	Min	Median	Max
Cash	10,637	0.200	0.147	0.013	0.164	0.749
Liquidity	10,637	0.208	0.152	0.013	0.171	0.767
ΔCash	10,519	0.004	0.033	-0.097	0.002	0.126
ΔLiquidity	10,519	0.004	0.034	-0.100	0.002	0.126
EBITDA	9,771	0.019	0.022	-0.076	0.018	0.088
Sales Volatility	10,438	0.045	0.040	0.004	0.032	0.215
Size	10,637	444,339	2,079,013	284	58,046	55,900,000
Q	10,637	0.840	1.154	0.072	0.460	7.914
Capex	9,756	0.009	0.013	-0.029	0.007	0.064
NWC	10,056	0.138	0.145	-0.205	0.133	0.598
Debt	10,637	0.146	0.151	0.000	0.102	0.630

Table 2: Means of variables for different subperiods

This table reports the averages of *Cash*, *Liquidity*, *Δ Cash*, *Δ Liquidity*, *EBITDA*, and *Sales Volatility* for subperiods and measures differences between periods. Definitions of variables are provided in Section 3.2. *Pre Crisis* is from 2019Q1 to 2019Q4. *Crisis I* is 2020Q1 and *Crisis II* is 2020Q2. *** and * indicate that the difference is statistically significant at the 1% or 10% level, respectively.

Period	*Cash*	*Liquidity*	*ΔCash*	*ΔLiquidity*	*EBITDA*	*Sales Volatility*
Pre Crisis	0.195	0.204	0.000	-0.001	0.021	0.045
Crisis I	0.202	0.211	0.013	0.013	0.017	0.044
Crisis II	0.214	0.222	0.011	0.011	0.011	0.046
Difference (*Crisis I - Pre Crisis*)	0.007*	0.007*	0.013***	0.013***	-0.003***	-0.001
Difference (*Crisis II - Pre Crisis*)	0.019***	0.018***	0.012***	0.012***	-0.010***	0.001

Table 3: Percentile statistics on the differences between the pre-crisis and crisis periods

This table reports percentile statistics of differences for *Cash*, *Liquidity*, and *EBITDA* between *Crisis I* and *Pre Crisis* and between *Crisis II* and *Pre Crisis*. Definitions of variables are provided in Section 3.2. *Pre Crisis* refers to the period from 2019Q1 to 2019Q4, *Crisis I* to 2020Q1, and *Crisis II* to 2020Q2.

Difference between *Crisis I* and *Pre Crisis*								
	p1	p5	p10	p25	p50	p75	p90	p99
Cash	-0.114	-0.049	-0.032	-0.009	0.006	0.023	0.046	0.143
Liquidity	-0.112	-0.051	-0.033	-0.010	0.006	0.024	0.045	0.149
EBITDA	-0.074	-0.040	-0.024	-0.011	-0.002	0.005	0.017	0.063
Difference between *Crisis II* and *Pre Crisis*								
	p1	p5	p10	p25	p50	p75	p90	p99
Cash	-0.122	-0.049	-0.028	-0.004	0.014	0.040	0.075	0.176
Liquidity	-0.131	-0.053	-0.030	-0.004	0.013	0.040	0.074	0.176
EBITDA	-0.094	-0.048	-0.032	-0.017	-0.007	0.000	0.009	0.040

Table 4: Baseline results

This table shows the estimation results for cash and liquidity holdings. The dependent variables are *Cash*, *Liquidity*, Δ *Cash*, and Δ *Liquidity*. All estimations include a constant term and firm fixed effects. Definitions of variables are provided in Section 3.2. The estimations employ standard errors that are clustered by firms and reported in parentheses. *** and ** denote statistical significance at the 1% and 5% level, respectively.

	(1)	(2)	(3)	(4)
Dep. Var.	*Cash*	*Liquidity*	*ΔCash*	*ΔLiquidity*
EBITDA	0.116***	0.096**	0.117***	0.120***
	(0.044)	(0.043)	(0.040)	(0.039)
*EBITDA*Crisis I*	0.109	0.134**	0.106**	0.114**
	(0.070)	(0.062)	(0.053)	(0.051)
*EBITDA*Crisis II*	0.094	0.127	0.006	-0.002
	(0.086)	(0.081)	(0.065)	(0.066)
Sales Volatility	0.016	0.009	-0.059	-0.069
	(0.144)	(0.145)	(0.100)	(0.102)
*Sales Volatility*Crisis I*	-0.002	0.006	0.029	0.046
	(0.029)	(0.028)	(0.028)	(0.029)
*Sales Volatility*Crisis II*	0.071**	0.085***	0.070**	0.079**
	(0.032)	(0.032)	(0.034)	(0.034)
Crisis I	0.005***	0.004***	0.008***	0.008***
	(0.002)	(0.002)	(0.001)	(0.001)
Crisis II	0.010***	0.008***	0.002	0.002
	(0.002)	(0.002)	(0.002)	(0.002)
Size	-0.026	-0.033*	0.001	0.002
	(0.019)	(0.019)	(0.014)	(0.014)
Q	0.007	0.007	-0.002	-0.001
	(0.005)	(0.004)	(0.002)	(0.002)
Capex	-0.340***	-0.349***	-0.558***	-0.593***
	(0.036)	(0.036)	(0.039)	(0.039)
NWC	-0.666***	-0.690***	-0.543***	-0.561***
	(0.030)	(0.030)	(0.023)	(0.023)
Debt	0.225***	0.236***	0.289***	0.298***
	(0.047)	(0.047)	(0.030)	(0.031)
	Firm FE	Firm FE	Firm FE	Firm FE
Observations	9,723	9,723	9,723	9,723
R^2	0.379	0.397	0.269	0.286

Table 5: Regression results for small versus large firms

This table shows the estimation results for cash and liquidity holdings by firms' size (measured in terms of their assets). The dependent variables are *Cash* and *Liquidity*. Columns (1) and (2) show the results for small and financially constrained firms, while columns (3) and (4) show the results for large and financially unconstrained firms. All estimations include a constant term and firm fixed effects. Definitions of variables are provided in Section 3.2. The estimations employ standard errors that are clustered by firms and reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
	(A) Small Firms (constrained)		(B) Large Firms (unconstrained)	
Dep. Var.	*Cash*	*Liquidity*	*Cash*	*Liquidity*
EBITDA	0.131**	0.106*	0.071	0.060
	(0.058)	(0.057)	(0.046)	(0.046)
*EBITDA*Crisis I*	0.123	0.161*	0.078	0.077
	(0.101)	(0.088)	(0.065)	(0.064)
*EBITDA*Crisis II*	0.080	0.123	0.120	0.141
	(0.114)	(0.104)	(0.085)	(0.089)
Sales Volatility	0.031	0.030	-0.038	-0.073
	(0.197)	(0.199)	(0.144)	(0.144)
*Sales Volatility*Crisis I*	-0.000	0.013	0.021	0.023
	(0.043)	(0.042)	(0.033)	(0.032)
*Sales Volatility*Crisis II*	0.083*	0.104**	0.082*	0.085*
	(0.047)	(0.047)	(0.048)	(0.048)
Crisis I	0.005**	0.004	0.004**	0.003
	(0.003)	(0.002)	(0.002)	(0.002)
Crisis II	0.010***	0.008***	0.008***	0.006**
	(0.003)	(0.003)	(0.003)	(0.003)
Size	-0.034	-0.047	-0.014	-0.016
	(0.034)	(0.033)	(0.014)	(0.014)
Q	0.007	0.008*	-0.001	-0.004
	(0.005)	(0.005)	(0.006)	(0.004)
Capex	-0.394***	-0.394***	-0.272***	-0.296***
	(0.056)	(0.056)	(0.035)	(0.036)
NWC	-0.672***	-0.685***	-0.671***	-0.716***
	(0.042)	(0.041)	(0.029)	(0.027)
Debt	0.156**	0.167**	0.345***	0.363***
	(0.069)	(0.069)	(0.045)	(0.045)
	Firm FE	Firm FE	Firm FE	Firm FE
Observations	5,045	5,045	4,678	4,678
R^2	0.351	0.362	0.472	0.508

Table 6: Regression results for low versus high payout firms

This table shows the estimation results for cash and liquidity holdings by firms' payout ratio. The dependent variables are *Cash* and *Liquidity*. Columns (1) and (2) show the results for firms with a low payout ratio (i.e., financially constrained firms), while columns (3) and (4) show the results for firms with a high payout ratio (i.e., financially unconstrained firms). All estimations include a constant term and firm fixed effects. Definitions of variables are provided in Section 3.2. The estimations employ standard errors that are clustered by firms and reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
	(A) Low Payout Firms (constrained)		(B) High Payout Firms (unconstrained)	
Dep. Var.	*Cash*	*Liquidity*	*Cash*	*Liquidity*
EBITDA	0.053	0.066	0.170***	0.132**
	(0.067)	(0.063)	(0.056)	(0.056)
*EBITDA*Crisis I*	0.224*	0.203*	0.024	0.071
	(0.114)	(0.113)	(0.087)	(0.077)
*EBITDA*Crisis II*	0.289**	0.262**	-0.032	0.029
	(0.129)	(0.125)	(0.105)	(0.098)
Sales Volatility	0.108	0.082	-0.021	-0.018
	(0.163)	(0.165)	(0.191)	(0.192)
*Sales Volatility*Crisis I*	0.021	0.032	-0.018	-0.008
	(0.042)	(0.039)	(0.040)	(0.040)
*Sales Volatility*Crisis II*	0.121***	0.128***	0.024	0.046
	(0.036)	(0.035)	(0.051)	(0.050)
Crisis I	0.004	0.004	0.006***	0.004**
	(0.003)	(0.003)	(0.002)	(0.002)
Crisis II	0.008***	0.007**	0.011***	0.007***
	(0.003)	(0.003)	(0.003)	(0.003)
Size	-0.061**	-0.069***	-0.013	-0.021
	(0.024)	(0.025)	(0.025)	(0.024)
Q	0.009	0.011	0.004	0.005
	(0.009)	(0.008)	(0.004)	(0.004)
Capex	-0.385***	-0.396***	-0.303***	-0.311***
	(0.057)	(0.058)	(0.045)	(0.045)
NWC	-0.707***	-0.735***	-0.631***	-0.651***
	(0.033)	(0.033)	(0.049)	(0.048)
Debt	0.213**	0.230**	0.252***	0.260***
	(0.089)	(0.092)	(0.048)	(0.047)
	Firm FE	Firm FE	Firm FE	Firm FE
Observations	4,236	4,236	5,487	5,487
R^2	0.465	0.486	0.322	0.335

Table 7: Estimation results for low versus high cash holding firms

This table shows the estimation results for cash and liquidity holdings by firms' cash holdings. The dependent variables are *Cash* and *Liquidity*. Columns (1) and (2) show the results for firms with a low cash ratio (i.e., financially constrained firms), while columns (3) and (4) show the results for firms with a high cash ratio (i.e., financially unconstrained firms). All estimations include a constant term and firm fixed effects. Definitions of variables are provided in Section 3.2. The estimations employ standard errors that are clustered by firms and reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
	(A) Firms with Low Cash Holdings (constrained)		(B) Firms with High Cash Holdings (unconstrained)	
Dep. Var.	*Cash*	*Liquidity*	*Cash*	*Liquidity*
EBITDA	0.036	0.044	0.130**	0.099*
	(0.035)	(0.034)	(0.057)	(0.056)
*EBITDA*Crisis I*	0.224***	0.232***	0.086	0.118
	(0.051)	(0.051)	(0.099)	(0.087)
*EBITDA*Crisis II*	0.067	0.109	0.102	0.138
	(0.083)	(0.085)	(0.111)	(0.102)
Sales Volatility	-0.092	-0.080	0.028	0.016
	(0.114)	(0.115)	(0.181)	(0.182)
*Sales Volatility*Crisis I*	0.045	0.030	-0.014	0.005
	(0.031)	(0.031)	(0.039)	(0.038)
*Sales Volatility*Crisis II*	0.120***	0.140***	0.076*	0.094**
	(0.042)	(0.041)	(0.044)	(0.044)
Crisis I	0.003*	0.002	0.006**	0.004*
	(0.001)	(0.001)	(0.002)	(0.002)
Crisis II	0.009***	0.007***	0.009***	0.006**
	(0.002)	(0.002)	(0.003)	(0.003)
Size	0.001	-0.002	-0.040	-0.051
	(0.015)	(0.014)	(0.032)	(0.031)
Q	0.006	0.006	0.005	0.006
	(0.004)	(0.004)	(0.005)	(0.005)
Capex	-0.239***	-0.270***	-0.417***	-0.412***
	(0.031)	(0.033)	(0.056)	(0.056)
NWC	-0.528***	-0.573***	-0.719***	-0.737***
	(0.030)	(0.029)	(0.036)	(0.036)
Debt	0.325***	0.345***	0.164**	0.176***
	(0.031)	(0.030)	(0.068)	(0.068)
	Firm FE	Firm FE	Firm FE	Firm FE
Observations	3,974	3,974	5,749	5,749
R^2	0.484	0.513	0.378	0.392

Table 8: Estimation results for high versus low leverage firms

This table shows the estimation results for cash and liquidity holdings by firms' leverage. The dependent variables are *Cash* and *Liquidity*. Columns (1) and (2) show the results for firms with a high leverage (i.e., financially constrained firms), while columns (3) and (4) show the results for firms with a low leverage (i.e., financially unconstrained firms). All estimations include a constant term and firm fixed effects. Definitions of variables are provided in Section 3.2. The estimations employ standard errors that are clustered by firms and reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
	(A) High Leverage Firms (constrained)		(B) Low Leverage Firms (unconstrained)	
Dep. Var.	*Cash*	*Liquidity*	*Cash*	*Liquidity*
EBITDA	0.071	0.054	0.200***	0.182***
	(0.053)	(0.056)	(0.067)	(0.064)
*EBITDA*Crisis I*	0.223***	0.235***	-0.010	0.034
	(0.062)	(0.063)	(0.137)	(0.120)
*EBITDA*Crisis II*	0.199*	0.225**	0.004	0.058
	(0.111)	(0.113)	(0.133)	(0.116)
Sales Volatility	0.192	0.195	-0.184	-0.206
	(0.192)	(0.192)	(0.199)	(0.199)
*Sales Volatility*Crisis I*	0.048	0.048	-0.048	-0.019
	(0.033)	(0.033)	(0.053)	(0.052)
*Sales Volatility*Crisis II*	0.070	0.075*	0.087*	0.116**
	(0.045)	(0.045)	(0.049)	(0.048)
Crisis I	0.001	0.000	0.011***	0.008***
	(0.002)	(0.002)	(0.003)	(0.003)
Crisis II	0.010***	0.009***	0.012***	0.007**
	(0.002)	(0.003)	(0.004)	(0.004)
Size	-0.016	-0.015	-0.060	-0.091**
	(0.021)	(0.021)	(0.042)	(0.037)
Q	0.006	0.005	0.006	0.007
	(0.004)	(0.004)	(0.007)	(0.006)
Capex	-0.286***	-0.292***	-0.437***	-0.454***
	(0.042)	(0.042)	(0.064)	(0.064)
NWC	-0.569***	-0.583***	-0.804***	-0.841***
	(0.045)	(0.046)	(0.035)	(0.034)
Debt	0.229***	0.226***	0.173	0.212*
	(0.047)	(0.048)	(0.108)	(0.108)
	Firm FE	Firm FE	Firm FE	Firm FE
Observations	5,170	5,170	4,553	4,553
R^2	0.386	0.388	0.402	0.438

Table 9: Estimation results for firms without versus firms with access to the bond market

This table shows the estimation results for cash and liquidity holdings for firms with and without access to the bond market. The dependent variables are *Cash* and *Liquidity*. Columns (1) and (2) show the results for firms without access to the bond market (i.e., financially constrained firms), while columns (3) and (4) show the results for firms with access to the bond market (i.e., financially unconstrained firms). All estimations include a constant term and firm fixed effects. Definitions of variables are provided in Section 3.2. The estimations employ standard errors that are clustered by firms and reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
	(A) Firms without Bond Market Access (constrained)		(B) Firms with Bond Market Access (unconstrained)	
Dep. Var.	*Cash*	*Liquidity*	*Cash*	*Liquidity*
EBITDA	0.116**	0.093**	0.184*	0.208**
	(0.046)	(0.045)	(0.099)	(0.096)
*EBITDA*Crisis I*	0.129*	0.156**	-0.183	-0.193
	(0.075)	(0.067)	(0.118)	(0.117)
*EBITDA*Crisis II*	0.110	0.145*	-0.167	-0.115
	(0.091)	(0.085)	(0.185)	(0.178)
Sales Volatility	0.004	-0.003	0.186	0.185
	(0.152)	(0.153)	(0.300)	(0.310)
*Sales Volatility*Crisis I*	-0.002	0.006	0.045	0.020
	(0.030)	(0.030)	(0.070)	(0.071)
*Sales Volatility*Crisis II*	0.075**	0.090***	0.240***	0.211**
	(0.034)	(0.034)	(0.091)	(0.095)
Crisis I	0.005***	0.004**	0.008***	0.006**
	(0.002)	(0.002)	(0.003)	(0.003)
Crisis II	0.009***	0.007***	0.010**	0.008**
	(0.002)	(0.002)	(0.004)	(0.004)
Size	-0.033	-0.041**	0.101***	0.101***
	(0.020)	(0.020)	(0.025)	(0.025)
Q	0.007	0.008*	-0.011	-0.018
	(0.005)	(0.005)	(0.013)	(0.013)
Capex	-0.350***	-0.356***	-0.317***	-0.348***
	(0.040)	(0.040)	(0.050)	(0.051)
NWC	-0.673***	-0.696***	-0.563***	-0.611***
	(0.032)	(0.031)	(0.049)	(0.045)
Debt	0.217***	0.232***	0.325***	0.303***
	(0.051)	(0.051)	(0.044)	(0.039)
	Firm FE	Firm FE	Firm FE	Firm FE
Observations	8,405	8,405	1,318	1,318
R^2	0.380	0.398	0.464	0.488

Table 10: Estimation results for firms that have access to credit lines and firms that do not

This table shows the estimation results of cash and liquidity holdings for firms without and with access to credit lines. The dependent variables are *Cash* and *Liquidity*. Columns (1) and (2) show the results for firms with no access to credit lines (i.e., financially constrained firms), while columns (3) and (4) show the results for firms with access to credit lines (i.e., financially unconstrained firms). All estimations include a constant term and firm fixed effects. Definitions of variables are provided in Section 3.2. The estimations employ standard errors that are clustered by firms and reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% level, respectively.

	(1)	(2)	(3)	(4)
	(A) Firms without Credit Lines (constrained)		(B) Firms with Credit Lines (unconstrained)	
Dep. Var.	*Cash*	*Liquidity*	*Cash*	*Liquidity*
EBITDA	0.104**	0.091**	0.202**	0.119
	(0.048)	(0.046)	(0.101)	(0.127)
*EBITDA*Crisis I*	0.099	0.128*	0.083	0.104
	(0.080)	(0.071)	(0.124)	(0.133)
*EBITDA*Crisis II*	0.101	0.132	-0.097	-0.034
	(0.095)	(0.088)	(0.189)	(0.195)
Sales Volatility	0.086	0.072	-0.305	-0.284
	(0.174)	(0.175)	(0.230)	(0.232)
*Sales Volatility*Crisis I*	-0.014	-0.013	0.046	0.054
	(0.034)	(0.033)	(0.048)	(0.050)
*Sales Volatility*Crisis II*	0.056	0.075**	0.131	0.135
	(0.034)	(0.034)	(0.118)	(0.116)
Crisis I	0.006***	0.005***	0.005*	0.003
	(0.002)	(0.002)	(0.003)	(0.003)
Crisis II	0.010***	0.008***	0.015**	0.012
	(0.002)	(0.002)	(0.007)	(0.007)
Size	-0.017	-0.026	-0.047	-0.043
	(0.020)	(0.019)	(0.033)	(0.034)
Q	0.008	0.008*	0.002	0.001
	(0.005)	(0.005)	(0.008)	(0.008)
Capex	-0.331***	-0.339***	-0.302***	-0.298***
	(0.040)	(0.041)	(0.083)	(0.086)
NWC	-0.687***	-0.709***	-0.601***	-0.635***
	(0.031)	(0.030)	(0.040)	(0.042)
Debt	0.225***	0.238***	0.213**	0.209**
	(0.054)	(0.054)	(0.087)	(0.089)
	Firm FE	Firm FE	Firm FE	Firm FE
Observations	8,338	8,338	1,385	1,385
R^2	0.381	0.399	0.452	0.456