The Real Effects of Credit Line Drawdowns*

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Using a unique data set of 470 public firms with credit lines, we study the purpose of drawdowns during the 2007–09 financial crisis. Our data show that credit line drawdowns had already increased in late 2007. Our results confirm that firms use drawdowns to sustain investment after an idiosyncratic liquidity shock. Using an instrumental-variable approach, we find that a one-standard-deviation increase in credit line drawdowns is associated with an increase of 12 percent in capital expenditures. During the financial crisis, this effect increased to 45 percent. We find only limited evidence that drawdowns were used to boost cash holdings.

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1. Introduction

How do corporate policies respond to an aggregate liquidity shock? Most firms depend on smoothly functioning credit markets to meet short-term liquidity needs and to finance long-term projects. A sharp drop in aggregate liquidity in the financial system disrupts credit markets, leading to lower credit supply from both bank and nonbank lenders. Firms that struggle to secure funding during an episode of low aggregate liquidity have to adjust borrowing, investment, and employment policies. The extent of these adjustments crucially depends on pre-committed credit lines arranged by firms as insurance against liquidity shocks, which are possibly the only outside financing option available during a period of market turmoil.

In this paper, we study the importance of drawdowns of credit lines for corporate policies in response to an aggregate liquidity shock. We examine credit line drawdown, investment, and cash holding behavior on a quarterly basis in the context of the 2007–09 financial crisis.[1] In our analysis, we construct a new measure of financing constraints based on credit availability that we use as an instrument for credit line drawdowns. We also study whether firm responses to the aggregate liquidity shock differ by firm characteristics, and assess the groups of firms for which the liquidity insurance provided by credit lines is most important.[2]

Based on a 10 percent sample of U.S. publicly traded firms, we construct a unique, hand-collected data set from regulatory filings (SEC 10-K and 10-Q) containing firm-level information on credit lines. We consider whether credit line drawdowns were used to finance investment and thus had real effects, or were used for precautionary cash-hoarding purposes—for instance, due to concerns about banks' health. Our quarterly, hand-collected data on credit lines during the financial crisis also have considerable quality advantages over

[1]Different from the 2020 COVID-19 shock—a large aggregate demand shock immediately signaling the start of a recession—the economic effects of the aggregate liquidity crisis starting with the collapse of the asset-backed commercial paper (ABCP) market in August 2007 were not seen at the time as the start of an economic downturn.

[2]Sufi (2009), Demiroglu and James (2011), and Santos and Viswanathan (2020) study the liquidity insurance role of credit lines.

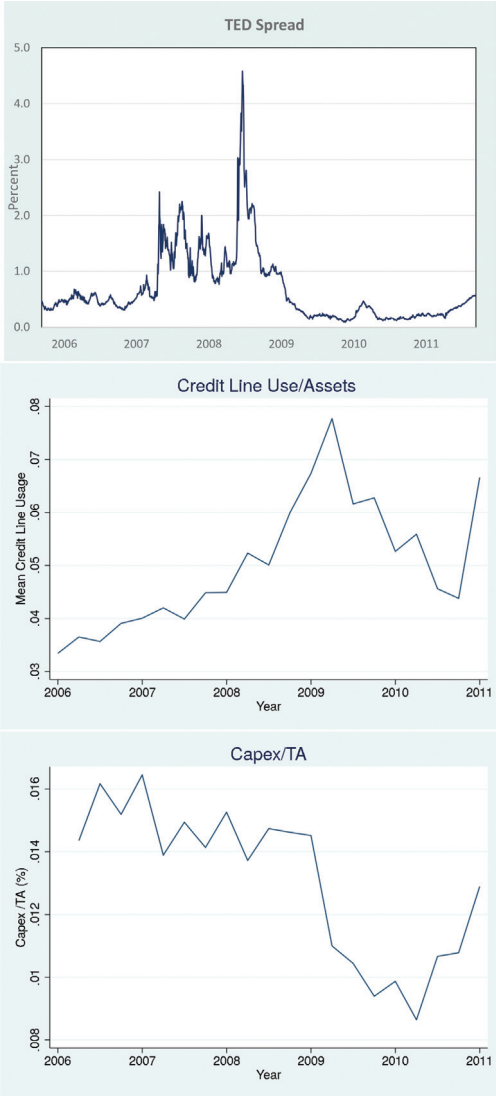
alternative credit line data sets such as Capital IQ, which are unreliable at a quarterly frequency (Mathers and Giacomini 2016) and are therefore used only at the annual frequency in prior work during a similar period (Acharya et al. 2014).[3] Unlike aggregate data, or survey data on a cross-section of firms, as previously used in the literature, our quarterly data set allows us to document differences across groups of firms (e.g., high- and low-cash-flow, large and small, investment-grade and non-investment-grade firms, and firms that pay and do not pay dividends). For these different types of firms, we study their use of credit lines as well as their investment and cash-management decisions before, during, and after the financial crisis. Thus, our quarterly data allow us to use firm fixed effects and study "within estimators" in panel regressions.

Our data show a novel fact: As seen in the upper panel of Figure 1, aggregate liquidity strains measured by the spikes in the TED spread (the difference between the three-month London interbank offered rate (LIBOR) and the three-month Treasury rate) started with the ABCP market collapse in the fall of 2007, continued with the subsequent volatility in short-term funding markets in early 2008, and reached their peak at the height of the financial crisis in the fall of 2008. Concurrent with the start of the liquidity crisis, and thus about a year earlier than what has been documented in the literature, as shown in the middle panel, the amount of drawn credit doubled between the beginning of 2007 and the peak of the crisis (2008:Q4), with spikes after the collapse of Bear Stearns (March 2008) and around the Lehman bankruptcy (September 2008).[4] During this period, firms in our sample managed to draw about $14 billion (11 percent of their unused credit lines), most of which was drawn by non-investment-grade firms (about $8 billion). When financial market stress receded in early 2009, firms started to repay their credit lines.

[3]Mathers and Giacomini (2016) show that Capital IQ total credit line data are consistent with regulatory filings in only 68 percent of the cases. For used and unused credit line amounts (and therefore for drawdowns), only 23 percent of the Capital IQ reported numbers were consistent with regulatory filings. Appendix C provides a detailed comparison and validation of our sample at the annual frequency.

[4]The large increase in credit line drawdowns around the Lehman failure has been documented by Ivashina and Scharfstein (2010) and Ippolito et al. (2016).

Figure 1. Average Revolving Credit Line Use and Average Capital Expenditure



Note: Credit line use is the average ratio of the amount of outstanding credit line balances to the firm's total assets for our sample of 470 firms. Capex is average quarterly capital expenditure divided by total assets. Outstanding credit lines balances are collected from SEC 10-Ks and 10-Qs. Capex and total assets are taken from Compustat.

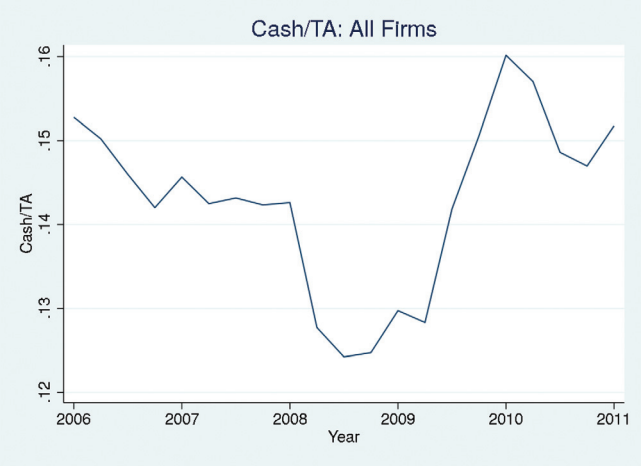
How did corporate investment behave during this time of low aggregate liquidity? The lower panel of Figure 1 shows that investment, measured by the ratio of capital expenditures to total assets, on average hovered around its pre-crisis level until the Lehman bankruptcy. This fact may be surprising, as the recession—dated to have started in December 2007—lowered firms' cash flows, and the unfolding financial crisis reduced aggregate liquidity and the availability of new credit. However, in its 2008 decision, the National Bureau of Economic Research (NBER) dating committee stated that while the economic expansion ended in December 2007, other measures including real manufacturing, wholesale-retail trade sales, industrial production, and employment estimates based on a household survey reached peaks between November 2007 and June 2008.[5] In other words, during the first half of 2008, the effects of the recession had not yet manifested in some sectors of the economy, hence firms made efforts to maintain their investment plans. The increase in drawdowns starting in late 2007 therefore suggests that corporations could have used drawdowns to sustain their capital expenditures. This explanation is consistent with theoretical work stating that firms can use pre-committed lines of credit in order to smooth unexpected shocks to their internal cash flows (Holmström and Tirole 2000).[6]

One alternative explanation for the drawdown pattern is that the uncertainty and concerns about bank health in times of liquidity shortage may have caused firms to draw on their loan commitments and hoard the cash. Figure 2 shows the behavior of corporate cash during the financial crisis. Cash holdings declined by over 10 percent during the fall of 2007 and then increased moderately up to the Lehman bankruptcy. Cash holdings increased significantly in the second half of 2009, which coincides with the reduction in investment and an aggregate repayment of credit lines after the peak of

[5]The NBER statement can be found here: http://www.nber.org/cycles/dec2008.pdf.

[6]Credit lines provide liquidity on borrower's demand and, being prearranged, remain available even if the supply of new credit drops. More generally, lines of credit are the dominant form of credit to businesses. For example, Shockley and Thakor (1997) document that most U.S. commercial bank lending to corporations is done via bank loan commitments.

Figure 2. Average Cash Holdings



Note: Cash is the average ratio of the sum of cash and cashlike instruments to total assets for our sample of 470 firms. Cash and total assets are taken from Compustat.

the crisis.[7] This aggregate pattern suggests a more nuanced explanation. Precautionary motives or bank health concerns are not evident during the first five quarters of the financial crisis but became salient after the collapse of Lehman Brothers. The corporate sector as a whole did not hoard the proceeds from drawdowns as cash until 2008:Q4, when drawdowns and cash holdings increased but investment plummeted. However, the Troubled Asset Relief Program (TARP) alleviated concerns about bank health almost immediately, as indicated by the substantial credit line repayments in early 2009, which suggests that the continued increase in cash holdings reflected tight credit conditions.

Despite this evidence, and perhaps due to a dearth of data sources, the empirical literature offers little discussion about the reasons for large drawdowns and their usage during times of low

[7]Increased cash holdings in the post-crisis period seems consistent with Berg (2018), who shows that firms with denied access to credit raise their cash for precautionary savings motives. Some credit denials after the financial crisis can be explained by violations, as shown by Chodorow-Reich and Falato (2022).

aggregate liquidity using detailed firm-level data. We fill this void. From the liquidity- and risk-management framework of Holmström and Tirole (2000), we derive four hypotheses related to the use of credit lines.[8] First, in general, firms that experience revenue or funding shocks are more likely to draw on their credit lines. Second, aggregate liquidity shocks, such as the one experienced during the global financial crisis, amplify this effect. Third, firms use the drawn funds to maintain investment spending. Fourth, firms use the drawn funds to hoard the cash for precautionary reasons.[9] In our tests, we also assess the effects of bank health on drawdown behavior.

To test our four hypotheses, we use both cross-section and panel regressions on a sample of 470 publicly traded U.S. non-financial firms with credit lines. Our quarterly data include credit line committed amounts, drawn amounts, and credit line availability—the time-varying portion of the line that is effectively available—which allows us to track restrictions on credit line limits. To assess whether banks' financial conditions affect drawdowns, we focus on the lead bank, as lead banks have an outsized effect on borrowers (Ivashina

[8]The theoretical literature emphasizes the ability to insure against revenue or, more generally, liquidity shocks as the key rationale for firms to have prearranged credit lines. Specifically, a firm may need liquidity in states of the world in which it has insufficient cash flows either to continue a current project—for instance, the firm may be unable to pay for intermediate goods or for a wages bill—or to realize new investment opportunities. In such an environment, credit lines can be efficient in providing the required funding (Boot, Thakor, and Udell 1987; Thakor 2005). The liquidity-management literature suggests that firms do not wait until the liquidity shock occurs to secure the funds to withstand the shock. Instead, the firm may either (i) self-insure by hoarding reserves in the form of cash or liquid securities that can be sold in the face of higher liquidity pressures, or (ii) secure a credit line from a financial institution (Holmström and Tirole 2000; Tirole 2006).

[9]The literature has documented a trade-off between cash holdings and credit line use (Acharya, Almeida, and Campello 2013). This trade-off suggests that firms raise cash and avoid drawing down their credit lines when external finance is costly relative to holding cash (Opler et al. 1999; and Almeida, Campello, and Weisbenner 2004). The marginal value of cash is larger for financially constrained firms and thus cash allows them to realize valuable investment opportunities (Faulkender and Wang 2006; and Denis and Sibilkov 2010). In Hypothesis 4, the underlying assumption is that drawing on a credit line and holding cash also reduce the probability of losing access to external financing—for instance, due to bank failure.

and Scharfstein 2010; and Chodorow-Reich 2014). We include financial characteristics of the lead bank, such as capital, profits, deposits, and loan losses, as bank control variables in our regressions.

To support our first hypothesis, we provide graphical evidence that firms facing a large drop in their revenues during the financial crisis were more likely to draw on their credit lines. Using difference-in-difference and panel regressions, we then show that firms increase their use of credit lines in response to adverse liquidity shocks, defined as a sufficiently large drop in their internal financing capacity (e.g., operating margin or sales growth).

Using our hand-collected data, and exploiting both across- and within-firm variation, we find that the effect of shocks to internal financing is stronger for bank-dependent firms: small, non-investment-grade firms, and firms not paying dividends. While we focus on U.S. firms, this finding is consistent with the international evidence on credit line usage from surveys (Jiménez, Lopez, and Saurina 2009; and Lins, Servaes, and Tufano 2010).

We also find support for our second hypothesis. The estimated effect of a drop in revenues on drawdowns is significantly larger during the crisis—that is, when aggregate liquidity was tight and other funding sources, such as bond issuance, were scarce. The effect is mainly driven by firms that are considered financially constrained and bank dependent (small, non-investment-grade firms, and firms not paying dividends).[10] The point estimates do not change when we include time-varying lead bank control variables. Indeed, we find little effect of bank health on drawdowns in general.[11]

To test our third hypothesis, and to reinforce our evidence that firms facing a drop in cash flows are more likely to draw on their credit lines, we provide graphical evidence that low-cash-flow firms

[10]This finding is consistent with previous results showing that financially constrained firms are more likely to draw on credit lines during the crisis (Huang 2010; Campello et al. 2011, 2012).

[11]In Table D.3 in Appendix D, we provide additional evidence that bank health was not the main driver of drawdowns. We find no differential effect for firms borrowing from lead banks that entered the financial crisis with low capital or high dependence on short-term wholesale funding. Thus, our findings indicate that credit line drawdowns during the crisis did not necessarily reflect firms' concerns about the financial health of their lenders. However, there is evidence that firms using bank loans paid higher spreads during the crisis, particularly if they borrowed from banks facing larger losses, as shown by Santos (2010).

that draw on their credit lines during times of low aggregate liquidity continued to invest more than low-cash-flow firms that did not use their credit lines. We then complement this evidence by estimating cross-sectional and fixed-effect panel regressions of capital expenditures on past credit line drawdowns, and firm and lead bank controls. Consistent with our hypothesis, we find that drawdowns are used to finance corporate investment. Our panel regression results suggest that a one-standard-deviation increase in the size of drawdowns (about 1.5 percent) is associated with a 3 percent increase in average capital expenditures (0.04 percent of total assets).

One concern with our empirical approach is the potential endogeneity of drawdowns, as both investment and financing decisions through drawdowns may occur simultaneously. To address this concern, we construct a new measure of financing constraints based on institutional features in credit line contracts that protect lenders against the possibility of borrowers' default. Specifically, we focus on restrictions to credit line availability as a proxy for financing constraints during financial crises.[12] Like covenants, these restrictions are exogenous to the firm, but unlike covenants—which were frequently waived during the financial crisis (Bird et al. 2022)—credit line availability is a continuous variable, observable in every quarter.[13] We find that credit line availability exhibits more variation than covenant breaches—only 3 percent of observations in our sample report covenant breaches—and can proxy for the intensity of financing constraints, by measuring how much credit a firm can effectively take at a given point in time. We argue that contract terms that restrict the availability of undrawn funds are bank imposed and thus exogenous to firms' decisions. With credit line availability being

[12]As we argue below, during the financial crisis and in the face of a systematic funding shock, banks were compelled to grant firms waivers in the event of covenant violations. Covenant violations then became less relevant to measure financing constraints during a financial crisis.

[13]Roberts and Sufi (2009) show that covenant violations reduce the use of credit lines. Acharya et al. (2014) show that bank monitoring of covenant compliance ensures the wise use of credit lines and encourages firms' drawdown decisions to take into account future cash flows, borrowing costs, and investment opportunities, as the cost of monitored liquidity insurance increases with liquidity risk.

predetermined, firms have little scope to influence their line availability when exposed to financial shocks.[14] We exploit the variation in access to credit lines, measured by credit line availability scaled by total assets (the credit line availability ratio), as our instrument for drawdowns.

Using an instrumental-variable approach in cross-section and panel regressions, we estimate the effect of drawdowns, this time conditional on firms having access to their credit lines, and find a bigger effect relative to our estimate using OLS fixed-effect regressions. Our estimates from the cross-section regressions suggest that a one-standard-deviation increase in the size of drawdowns (about 8 percent in the cross-section over the crisis) is associated with a 25 percent increase in average capital expenditures during the financial crisis. In panel regressions, our estimates indicate that a one-standard-deviation increase in the size of drawdowns (about 1.5 percent) is associated with a 12 percent increase in average capital expenditures (0.2 percent of total assets) during benign times. The effect is much larger, about 45 percent increase in capital expenditures, during the financial crisis. This amplification during the crisis is particularly strong for low-cash-flow firms. These firms are financially constrained and hence more likely to rely on credit lines to smooth liquidity shocks.

Our results are robust to the use of alternative measures of investment (e.g., changes in plant, property, and equipment), and continuous variables that control for the effect of the financial crisis (e.g., the TED spread, and lending standards from the Senior Loan Officer Opinion Survey, SLOOS).

We then test our fourth hypothesis, namely, firms drawing on their credit lines hoard the cash for precautionary reasons. This could have been the case if a firm had concerns about the solvency of their lenders during the financial crisis and the possibility that the lenders might not honor their credit line commitments. If credit line drawdowns were in fact largely precautionary, then firms' cash holdings should increase almost one-to-one with drawdowns. However, we find no evidence that drawdowns differentially increased cash

[14]Our data show that a firm placed at the 25th percentile of the credit line availability distribution can use about 85 percent of its remaining line, and a firm at the 10th percentile of the distribution can use only 60 percent.

holdings more during the financial crisis than at other times. It is possible that at least some drawdowns after the collapse of Lehman Brothers in the fall of 2008 were precautionary, as indicated by the aggregate data. However, this one-quarter effect is hard to detect, as for the purpose of this paper the financial crisis is defined from 2007:Q3 to 2008:Q4.

Our finding that firms able to access their credit lines use drawdowns for investment is consistent with Chava and Roberts (2008), who use a regression discontinuity around debt covenant violations and show that investment drops after such violations.[15] Our results also suggest that, at least early in the crisis, banks continued to perform their role as liquidity insurers for nonfinancial firms.[16]

In sum, we conclude that financially constrained firms, specifically low-cash-flow firms, enjoyed the liquidity insurance provided by credit lines during times of low aggregate liquidity to sustain their investment rather than to hoard the cash.[17]

This conclusion has important financial stability implications. Our data suggest that drawdowns of similar magnitude to what occurred during the financial crisis (11 percent of $2.1 trillion in unused commitments of U.S. banks as of 2019:Q4) would imply a bank credit expansion of about $235 billion in the form of drawdowns. This amount is about three times the current annual growth of bank commercial and industrial (C&I) loans.[18] Considering the large drawdowns during times of financial stress, it is important for regulators to make sure that banks remain liquid and well capitalized so as to not only meet the surging demand for credit line draws but also absorb potential losses associated with the increase in loan supply, in the event of further deteriorations in macroeconomic conditions. That way, regulatory authorities can guarantee that banks

[15] Falato and Liang (2016) find that debt covenant violations also affect employment.

[16] Kashyap, Rajan, and Stein (2002) and Gatev and Strahan (2006) argue that banks have a natural advantage in the provision of liquidity.

[17] At the same time drawdowns from ABCP backup lines and anticipated losses in loans and securities holdings led to liquidity hoarding by banks (Berrospide 2021).

[18] According to S&P Global, Leveraged Commentary and Data, credit line drawdowns in syndicated loan markets associated with the COVID-19 pandemic in March and April 2020 totaled $304 billion.

continue to fulfill their role as liquidity insurance providers and help sustain aggregate investment.

The remainder of the paper is organized as follows. Section 2 describes the data collection process and presents summary statistics and drawdowns during the sample period. In Section 3, we explore drawdown determinants. Section 4 assesses the real effects of credit line drawdowns. Section 5 discusses the findings. Section 6 concludes.

2. Data

2.1 Sample Construction

We use two main data sources for our firm-level data: Standard and Poor's Compustat and Security and Exchange Commission (SEC) regulatory filings (10-Ks and 10-Qs).[19] We chose to hand-collect the credit line data from regulatory files, as these filings allow us to construct our novel measure of financing constraints, credit line availability—that is, how much of the credit line limit is actually available to the firms. Credit line availability is based on contractual clauses and is reported, to the best of our knowledge, only in regulatory filings. We use data from regulatory filings (FR Y-9C and Call Reports) to construct metrics for the firms' lead bank financial conditions.

The downside of hand-collecting data is that we have to limit the sample size. As part of our sample selection criteria for the universe of Compustat firms, we require that the firm remained in operation between 2005:Q4 and 2008:Q3, and was not an agricultural, utility, or financial service company. We stratify the remaining firms by industry and size to ensure the representativeness of our sample. We then randomly sample a total of 600 nonfinancial firms (about 10 percent of the Compustat universe) in 75 strata. Unfortunately, we could not sample based on firms having a credit line, as this information is only available in the regulatory filings.[20]

[19]The Standard and Poor's Compustat data was accessed via WRDS from the University of Pennsylvania.

[20]While not all firms have credit lines, we decided against sampling with replacement to keep our sample size of 600 firms with credit lines for two reasons. First, we only learned which firms had no credit line after a lengthy data-gathering process. Second, by not replacing the firms, we can easily scale up the drawdown

2.2 Credit Lines and Their Features in Regulatory Filing

To identify credit line users, we conduct a keyword search in the regulatory filings. Specifically, we search for "credit facility," "credit facilities," "credit line," "credit lines," "line of credit," "lines of credit," "loan facility," "loan facilities," "revolving facility," "term loan," and "term loans." We then read the respective paragraphs to extract the relevant information on credit lines and their use.[21] We exclude bridge facilities, merger facilities, floor plan facilities, and credit lines denominated in foreign currency.

A typical credit line contract includes debt covenants in the form of requirements on maximum leverage, minimum profitability, and quality of collateral (the most common being receivables and inventories). In some cases, there are also material adverse change (MAC) provisions allowing the lender to terminate the loan agreement if the borrower experiences material changes in its financial conditions. These provisions are subject to legal interpretation, and invoking them usually leads to litigation.[22] The most common covenant violations are failure to submit the SEC filings on time; minimum earnings before interest, taxes, depreciation, and amortization (EBITDA) violations; collateral and cash flow violations; and

to the population with respect to credit line use. As part of our validity checks, we confirmed previously documented differences between firms with and without credit lines (as in Acharya et al. 2014), which in our view mitigates potential concerns about changes in our sample stratification due to the lack of replacement. We provide support to validate our sampling assumptions in Appendix C. In our view, the sample is therefore representative when studying credit-line-related questions in the U.S. public firm population but not necessarily for other outcomes. We use the company's name and tax number to obtain the 10-Ks and 10-Qs for each firm from 2005:Q4 through 2010:Q4.

[21]Since firms sometimes convert credit line debt into term loans, we found it useful to include "term loan(s)" in the search. We observe that sometimes term loan facilities are not immediately drawn, though most are drawn within the quarter they are received. We also find situations in which firms have a combination of term loans and delayed draw term loans. These latter term loans must usually be drawn within a year of commitment, otherwise the firm pays a commitment fee on the remaining unused portion.

[22]A bank may not invoke MAC provisions when it is in good financial health. However, when needed, a bank may directly influence the volumes of drawdowns by reducing credit availability to borrowers who are not in compliance with covenants or whose collateral has declined in value. For a more comprehensive discussion, see Sufi (2009) and Huang (2010).

leverage ratio violations. After a covenant violation, firms generally experience an increase in the interest rate margin. After subsequent violations over several quarters, the firm could be forced to either enter into a forbearance agreement and negotiate another line (possibly with another bank) or stop borrowing from existing credit lines (e.g., through credit line termination and a requirement to repay outstanding balance).

Our firm-level data from regulatory filings include the total amount of the credit facility, the amount drawn, the remaining unused amount, the amount available, and information on covenant violations and terms of credit described above. Appendix A describes in detail the information we extract from footnotes to financial statements in regulatory filings, and the complementary financial variables from Compustat. Appendix B presents examples that illustrate how we construct our credit line variables (used, unused, and available amounts) based on the data from regulatory filings. We focus our analysis on revolving credit lines (we exclude term loans), as they are the most common form of bank lending to nonfinancial firms. Revolving lines are the amount that firms can draw down, repay, and continue drawing down for the duration of the facility.

We also hand-collect information on firms' lead banks from SEC regulatory filings (8-Ks).[23] We identify about 130 financial institutions in our sample, and obtain information for 87 banks lending to about 450 firms between 2005:Q4 and 2010:Q4. For the remaining institutions with no financial information (which include nonbank lenders, as well as small and large foreign banks), we use an indicator variable to account for their missing data in our analysis.

2.3 Sample Summary Statistics

The use of credit lines is widespread for firms in our sample. Of the original 600 nonfinancial firms in the sample, 470 have a credit line at some point in time. For the remainder of the paper we restrict our attention to these 470 firms. Table 1 provides summary statistics for the variables in both the panel regression (panel A) and the

[23]We supplement the data collection with information from the Thomson-Reuter's LPC Dealscan database matched with Compustat financial data, following Michael Robert's matching procedure. We accessed the Dealscan-Compustat link data via WRDS, from the University of Pennsylvania.

Table 1. Summary Statistics of Regression Variables

	N	Mean	Std. Dev.	25%	Median	75%
A. Firm-Quarter Level—Panel Regression Analysis						
Firm Variables:						
Sales Growth	7,739	0.031	0.219	–0.053	0.017	0.087
Cash Flow/TA	7,739	0.027	0.041	0.017	0.031	0.045
Cash/TA	7,739	0.136	0.143	0.028	0.088	0.204
Size	7,739	6.499	1.864	5.161	6.577	7.767
Tangible Assets/TA	7,739	0.794	0.202	0.666	0.860	0.969
Market-to-Book (MTB) Ratio	7,739	1.691	1.085	1.101	1.426	1.993
MTB over 8 Dummy	7,739	0.005	0.070	0.000	0.000	0.000
Indicator for Missing MTBA	7,739	0.040	0.196	0.000	0.000	0.000
Leverage	7,739	0.255	0.241	0.058	0.215	0.376
Cash Flow Volatility	7,739	0.019	0.022	0.008	0.013	0.022
MA Dummy	7,739	0.023	0.151	0.000	0.000	0.000
Capital Expenditures/TA	7,739	0.013	0.016	0.004	0.008	0.016
Revolving Line/TA	7,739	0.173	0.223	0.066	0.129	0.232
Drawdown Dummy	7,739	0.209	0.407	0.000	0.000	0.000
Drawdown Size	7,739	0.0003	0.015	0.000	0.000	0.000
Credit Line Availability Ratio	7,739	0.106	0.099	0.040	0.084	0.148
Lead Bank Variables:						
Tier 1 Capital/RWA	7,739	0.072	0.049	0.069	0.085	0.105
ROA	7,739	0.001	0.003	0.000	0.001	0.003
Core Deposits/TA	7,739	0.294	0.215	0.090	0.295	0.484
Net Charge-offs/TA	7,739	0.002	0.002	0.000	0.001	0.003
Missing Lead Bank	7,739	0.212	0.409	0.000	0.000	0.000
Macrovariables:						
Crisis Dummy	7,739	0.324	0.468	0.000	0.000	1.000
SLOOS	7,739	18.663	29.918	–7.100	7.500	39.600
TED Spread	7,739	69.315	57.318	19.396	46.333	97.855
B. Firm Level—Cross-Sectional Regression Analysis						
Change in Capital Expenditures/TA	453	–0.001	0.009	–0.003	–0.000	0.002
Change in Cash/TA	453	–0.014	0.082	–0.043	–0.002	0.020
Change in Drawdown Size	453	0.019	0.082	0.000	0.000	0.035
Pre-crisis Availability/TA	451	0.143	0.128	0.060	0.110	0.199
Pre-crisis Committed/TA	451	0.211	0.184	0.082	0.166	0.294
Pre-crisis Cash Flow/TA	453	0.029	0.037	0.020	0.032	0.045
Pre-crisis Sales Growth/TA	453	0.039	0.081	–0.002	0.023	0.056
Pre-crisis Size	453	6.311	1.823	4.977	6.355	7.624
Pre-crisis Tangible Assets/TA	453	0.806	0.192	0.688	0.868	0.971
Pre-crisis MTB Ratio	453	1.950	1.166	1.293	1.689	2.246
Pre-crisis Leverage	453	0.232	0.208	0.065	0.198	0.344
Pre-crisis Cash Flow Volatility	453	0.020	0.018	0.009	0.014	0.024

Note: This table provides the summary statistic for all regression variables used in both the panel regression analysis (sample of 470 firms) in panel A, and the cross-sectional regression analysis (453 firms with available financial information in the pre-crisis period, 2005:Q4–2007:Q1) in panel B. Change in Capital Expenditures/TA, Cash/TA, and Drawdown Size refer to the change from pre-crisis to crisis (2007:Q3–2008:Q4). All control variables are defined in Appendix A.

cross-sectional regression (panel B) analyses. As shown in panel A, for the average firm, revolving credit lines are about 17 percent of their assets and, conditional on being positive, drawdowns are about 2 percent.[24] Firms with credit lines in our sample are on average larger than the average nonfinancial firm in Compustat. They also tend to have higher leverage than the average firm in Compustat (a debt-to-asset ratio of 0.26 compared with 0.20 for the average firm in Compustat). Consistent with previous findings on the trade-off between cash and credit lines, the firms with credit lines in our sample hold on average 8 percentage points less cash (about 14 percent). About 70 percent of firms in our sample draw funds from their credit lines at some point between 2005 and 2010. Furthermore, 28 percent of firms did not draw on their credit lines during the financial crisis, while 25 percent drew at least one-third of their credit lines during the crisis. As shown in panel B, during the financial crisis, the reduction in the cash-to-assets ratio (1.4 percentage points) was larger than that of the capital-expenditures-to-assets ratio (0.1 percentage point), consistent with the notion that firms increased the size of their drawdowns (1.9 percent of total assets) to maintain their investment plans.

The average lead bank in our sample operates with a regulatory capital ratio (tier 1 capital/RWA) of 7 percent. The average capital ratio increased from less than 6 percent at the peak of the financial crisis in 2008 to 9.5 percent by year-end 2010. The average lead bank's share of core deposits in total assets is 29 percent, implying that, on average, these banks had significant dependence on short-term wholesale funding, particularly during the months leading to the financial crisis. Net charge-offs were on average 0.2 percent of total assets during our sample period (increasing from 0.05 percent in mid-2007 to 0.3 percent by year-end 2009). The high level of net

[24]For comparison, Sufi (2009) reports that 85 percent of firms in his sample have a line of credit between 1996 and 2003, and the lines of credit represent about 16 percent of their assets. Campello et al. (2011) report the following average ratios (as percent of total assets): credit lines of 24 percent, cash holdings of 12 percent, and cash flows of 9 percent, for their sample of 397 U.S. nonfinancial firms based on their 2009 CFO survey. The difference in the cash holdings and cash flow ratios reflects not only the differences between our definitions of cash and cash flows and theirs, but also the fact that our sample covers the financial crisis period, when firms may have boosted their cash holdings and savings from cash flows in anticipation of liquidity pressures.

charge-offs, on average, explains the lead banks' relatively low profitability (i.e., return on assets of 0.1 percent on average relative to 0.3 percent in mid-2006).

3. Corporate Borrowing during the Financial Crisis

In this section, we first provide descriptive evidence on aggregate credit lines and drawdowns over our sample period. Next, we turn to the behavior of cash holdings and investment over the sample period, and discuss alternative sources of financing. Last, we study the firm-level determinants of credit lines drawdowns.

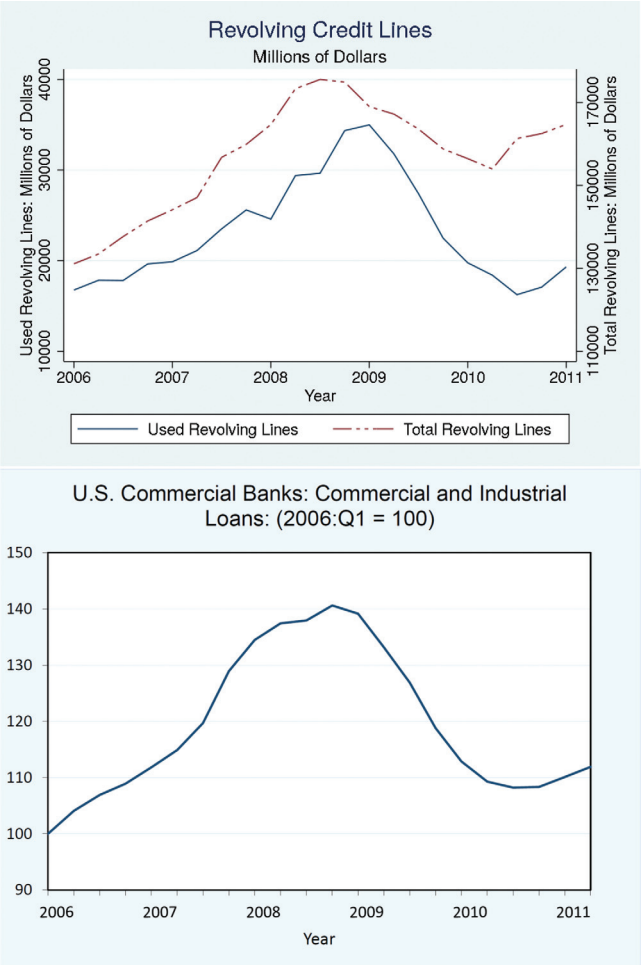
3.1 Credit Lines over the Sample Period

We start our analysis with descriptive evidence on credit lines during the financial crisis. Our crisis definition spans from the collapse of ABCP markets to the implementation of the Troubled Asset Relief Program (TARP), which is from 2007:Q3 to 2008:Q4. The upper panel of Figure 3 shows the total use of revolving credit lines for all firms in our sample. Firms started to tap their revolving credit lines during the first half of 2007 and continued to increase credit line use after the beginning of the financial crisis, which started with a panic in short-term funding markets in August 2007.[25] Credit line use (the solid line) increased during 2007, accelerated after the Bear Stearns failure in March 2008, and reached its peak during the fourth quarter of 2008 after the collapse of Lehman Brothers. Credit line use in our sample rose by about $14 billion between 2007:Q1 and 2008:Q4. Total revolving lines of credit (dashed line) followed a pattern similar to credit line use. They went up by $22 billion during the same period, with almost all of the increase occurring in 2007, suggesting that credit supply tightened significantly in summer 2008.

The drawdowns before the Lehman collapse have not been documented before and are consistent with low aggregate liquidity reducing the availability of other means of financing. The spike in use

[25] One possibility is that most of the increase in credit line use is driven by firms that use their credit lines to back up the issuance of commercial paper. However, we do not find evidence that this behavior is driven by the 32 firms in our sample that issue commercial paper. In fact, we find no difference between firms with commercial paper backup lines of credit and all other firms in the sample.

Figure 3. Credit Lines and Bank C&I Loans



Note: Used revolving lines is the sum of outstanding credit line balances for our sample of 470 firms. Total revolving lines is the sum of credit line size. Bank C&I loans is an index of total outstanding loans to nonfinancial corporations normalized to the first quarter of 2006. Credit line information is collected from SEC 10-Ks and 10-Qs. Bank C&I loans are aggregated across U.S. commercial banks using Call Report data.

and the reduction in total credit lines in 2008:Q4 are consistent with the evidence from aggregate data on new syndicated loans presented in Ivashina and Scharfstein (2010). The increase in credit

line utilization amounts to about 11 percent of the 2007:Q1 unused commitments, suggesting that many firms relied on their credit lines to weather the financial crisis. For comparison, the lower panel of Figure 3 shows that total bank commercial and industrial (C&I) lending exhibits the same patterns as credit line use.[26]

3.2 Drawdowns, Cash Holdings, and Investment

Our main hypothesis is that during the financial crisis (2007:Q3–2008:Q4) firms drew their credit lines to sustain their investment plans. One implication of this hypothesis is that firms that experienced a significant drop in their internally generated funds (e.g., cash flows) should exhibit larger drawdowns relative to firms whose internal funds were not affected by the crisis.

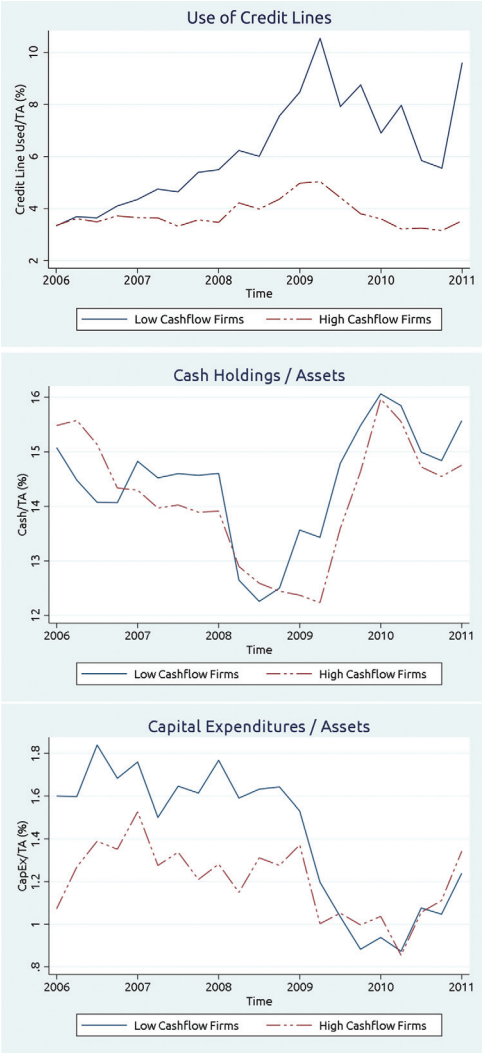
We split our sample of firms into two groups based on the change in their cash flows, measured as operating margin, from pre-crisis to the crisis period. We consider firms with a large drop in operating margin between pre-crisis and crisis (above the median drop) as low-cash-flow firms, and those with small drop in operating margin (below the median drop) as high-cash-flow firms.

Figure 4 plots the credit line use, the cash-to-total-assets ratio, and the capital-expenditures-to-total-assets ratio for low- and high-cash-flow firms. The upper panel shows that low-cash-flow firms (solid line) started to draw their lines earlier and, on the whole, drew more on their credit lines over the financial crisis than high-cash-flow firms (dashed line).

The middle panel of Figure 4 shows that both groups reduced their cash holdings during the crisis. However, low-cash-flow firms burned through their cash at a considerably faster pace. After 2009, both groups significantly increased their cash holdings. The fact that cash holdings decreased precisely when credit line drawdown increased is the first piece of evidence that credit line drawdowns during the crisis were used as a complement to cash in financing corporate expenditure and not to hoard the cash for precautionary reasons. This is in contrast to the hypothesis that drawdowns were

[26]Cornett et al. (2011) and Acharya and Mora (2015) find evidence of bank liquidity hoarding mostly in response to the failure of Lehman, which suggests that from the third quarter of 2008, banks may have been unable to continue to function as liquidity insurers for nonfinancial corporations.

Figure 4. Credit Line Use, Investment, and Cash Holdings of Low- and High-Cash-Flow Firms



Note: Credit Line Used is the average ratio of the amount of credit line used to total assets in our sample of 470 firms. Cash/Assets and Capex/Assets are the average ratio of cash and capital expenditures to total assets, respectively. Firms with below (above) median change in operating margin from pre-crisis to crisis are "low-cash-flow" ("high-cash-flow") firms. Cash, capex, and total assets are taken from Compustat. Credit line information is collected from SEC 10-Ks and 10-Qs.

precautionary. If firms had drawn on their credit lines for precautionary reasons or out of concerns about bank health, they would have taken steps to at least preserve, if not increase, their cash holdings.

The bottom panel of Figure 4 also provides suggestive evidence that low-cash-flow firms tried to keep up with their investment spending even more than the high-cash-flow firms. Capital expenditure only tanked for both groups after the failure of Lehman Brothers. This timing is instructive. Capital expenditures remain almost unchanged precisely at the time when firms were drawing on their credit lines and simultaneously reducing their cash up to the peak of the crisis. Both low- and high-cash-flow firms cut investment, repaid their credit lines, and started to hoard cash afterwards.

In sum, this figure suggests that firms that experienced a negative shock to their net revenues relied on cash and credit line drawdowns during the financial crisis (2007:Q3–2008:Q4) for business expenditure and to maintain their investment plans. This pattern reverses after the height of the crisis.[27] As such, this graphic evidence suggests that credit lines proceeds were instrumental in supporting investment during the crisis.

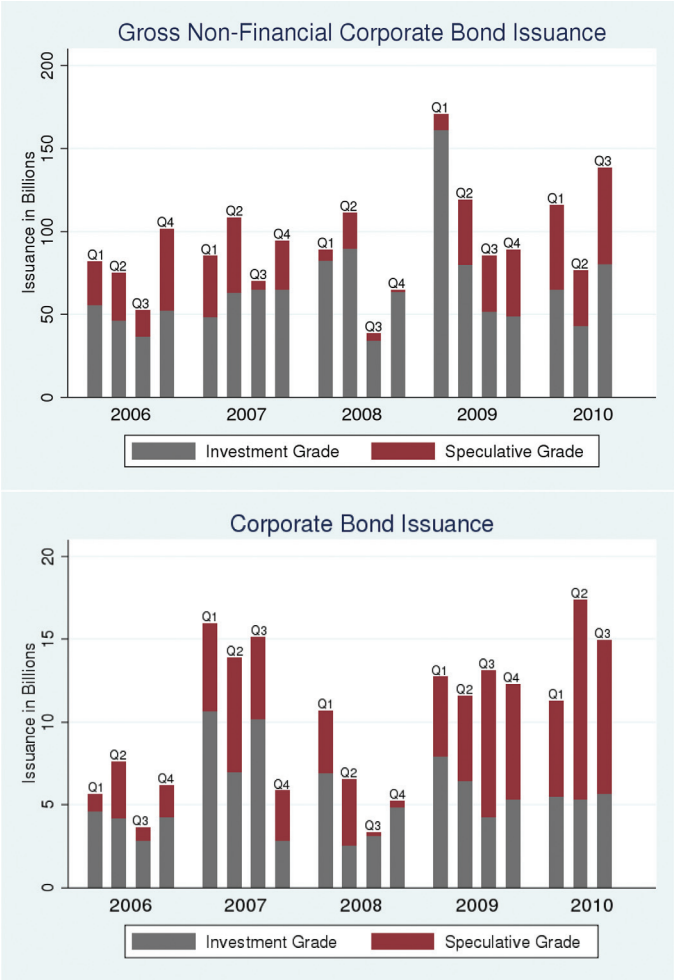
3.3 Credit Lines or Alternative Financing Sources?

To ensure that our results on investment spending are in fact driven by credit line drawdowns and not by the use of alternative financing sources that could have been available, we study both overall bond issuances and bond issuance by firms in our sample during the financial crisis. The top panel of Figure 5 plots corporate bond issuances for all nonfinancial firms reported in Bloomberg. On aggregate, bond issuance dropped significantly from 2007:Q2 to 2008:Q4, especially for speculative-grade firms. First Data Corp.'s issuance of $6 billion LBO (leveraged buyout) bonds accounts for almost all speculative-grade issuances in the United States in 2008:Q3.[28] Furthermore, there were essentially no speculative-grade issuances in the aftermath of the Lehman failure. Similarly, investment-grade firms

[27] We also find a similar pattern if instead of changes in operating margin we use changes in sales growth to split firms in our sample.

[28] We do not find that the firms in our sample were engaged in significant private placements under rule 144(a).

Figure 5. All and Sample Corporate Bond Issuances



Note: Corporate bond issuances are the total amount of bonds issued in each quarter. The top panel shows the overall bond market issuances and the bottom panel shows issuances by the 470 firms in our sample. Bond issuances are taken from Capital IQ.

did not increase bond issuance early in the crisis. In the second half of 2008, issuances by investment-grade firms dropped significantly. While bond issuance recovered in 2009, the spike in bond issuance in

2009:Q1 shown in the figure needs to be assessed with caution, as it is driven by a few investment-grade firms with very large issuances. As such, the aggregate bond issuance pattern moves exactly opposite to the aggregate credit line drawdown patterns, suggesting that credit line drawdowns, and not other financing sources, were used to maintain investment spending.

The bottom panel of Figure 5 plots corporate bond issuances for firms in our sample. Bond issuances appear to be low compared with the full sample in 2006; however, in all other years, bond issuance of firms in our sample mimics that for firms in the full sample. Bond issuance dropped by the start of the financial crisis and recovered only in 2009. Since bond issuance of firms in our sample drops during the financial crisis precisely when credit line drawdowns increase, we conclude that credit lines were the only financing available to firms during the financial crisis.

In sum, this pattern suggests that bond issuances were neither a substitute for nor a complement to credit line drawdowns during the financial crisis.[29] Firms had to rely on credit line drawdowns to finance capital expenditures.

3.4 Determinants of Credit Line Drawdowns

3.4.1 Difference-in-Difference Approach

To better understand the drawdown patterns documented in the sections above, we build on the liquidity- and risk-management framework of Holmström and Tirole (2000), which emphasizes the necessity to insure against revenue or, more generally, liquidity shocks to avoid the liquidation of current projects or missing out on investment opportunities. Firms can insure themselves against those shocks by either holding liquid assets or by arranging credit lines contracts. Thus, the focus of this section is the liquidity insurance provided by credit lines. Figure 4 already suggests that firms experiencing large drops in cash flows during the financial crisis relied more on credit lines.

We test the first key prediction of the liquidity insurance hypothesis, namely, that firms experiencing an adverse liquidity shock are

[29] One potential reason is the sharp increase in bond spreads during the financial crisis.

the ones more willing to use their credit lines. Our empirical strategy follows Campello et al. (2011). Specifically, as in Section 3.2, we split the sample into low- and high-cash-flow firms. Using this split, we test the prediction that low-cash-flow firms draw more on their credit lines using the following difference-in-difference regression:

$$Credit\ Line\ Use_{i,t} = \tau_t + \beta_1\ Low\ cash\ flow_i + \beta_2\ Low\ cash\ flow_i \times after_t + \gamma \cdot X_i + \epsilon_{i,t}, \quad (1)$$

where $Credit\ Line\ Use_{i,t}$ is the quarterly use of revolving lines divided by total assets. $Low\ cash\ flow_i$ is a dummy variable identifying the low-cash-flow firms and $after_t$ is a dummy variable that takes the value of 1 from 2007:Q3 on. Vector X_i includes the following firm controls: size (measured as the log of total assets), cash to total assets, leverage, and the market-to-book (MTB) ratio. We account for missing values of the MTB ratio by setting MTB ratio equal to zero and simultaneously including as an additional control a dummy variable that takes the value of 1 when the firm does not report its market capitalization (and hence its MTB ratio), and zero otherwise.[30] It also includes time fixed effects. We expect a positive coefficient on $Low\ cash\ flow_i$ and the interaction term ($\beta_2 > 0$), as drawdowns should increase for firms that face an adverse shock to their revenues during the crisis.

Table 2 shows the results of estimating Equation (1). The first three columns show the results for OLS specifications. In the specification without firm controls, we find a positive and significant coefficient on the interaction term (β_2), while the linear terms are insignificant (column 1). This result is robust to controlling for firm characteristics (column 2). We then include the following controls for the firm's lead bank health: tier 1 capital/RWA, return on assets (ROA), share of core deposits in total assets, net charge-off ratio, and an indicator for missing bank variables.[31] The point estimate on the interaction term is identical to the specification without bank

[30]This treatment only applies to 20 firms, which is less than 5 percent of the firms in our sample.

[31]The missing bank variable indicator is equal to 1 if the lead bank was a financial institution that did not file regulatory FR Y9-C or Call Reports.

Table 2. Difference-in-Difference Regression Results: Credit Line Use

	OLS Regression			Fixed-Effect Regression		
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Low Cash Flow * After	0.020*	0.023*	0.023*	0.025***	0.023***	0.023***
	(0.012)	(0.013)	(0.013)	(0.006)	(0.006)	(0.006)
Low Cash Flow	0.007	0.013*	0.013*			
	(0.007)	(0.008)	(0.008)			
Size		–0.016***	–0.015***		–0.033*	–0.032
		(0.006)	(0.006)		(0.020)	(0.020)
Cash/TA		–0.088**	–0.093***		–0.168**	–0.169**
		(0.035)	(0.032)		(0.077)	(0.077)
Leverage		0.199**	0.197**		0.261***	0.262***
		(0.093)	(0.091)		(0.072)	(0.072)
Market-to-Book Ratio		0.013	0.014		0.005	0.005
		(0.014)	(0.014)		(0.008)	(0.008)
Indicator for Missing MTBA		–0.065***	–0.066***		–0.030	–0.029
		(0.019)	(0.019)		(0.020)	(0.021)
Bank Tier 1 Capital/RWA			–0.034			–0.099*
			(0.102)			(0.056)
Bank ROA			–0.236			–0.064
			(0.384)			(0.230)
Bank Core Deposits/TA			0.004			0.012
			(0.026)			(0.012)
Net Charge-offs/TA			–0.435			–2.204*
			(2.686)			(1.273)
Missing Lead Bank			0.011			0.006
			(0.013)			(0.007)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	No	No	No	Yes	Yes	Yes
Adjusted R^2	0.004	0.101	0.101	0.459	0.485	0.485
Number of Obs.	7,739	7,739	7,739	7,739	7,739	7,739

Note: This table summarizes difference-in-difference regression results with credit line use as the dependent variable. Credit line use is scaled by total assets. Low cash flow is an indicator variable equal to 1 if the firm faces a large drop in its operating margin. A large drop is defined as below the median change in operating margin from before to after the crisis. *After* is an indicator variable equal to 1 from 2007:Q3 on and 0 between 2005:Q4 and 2007:Q2. Firm and bank controls are measured as of previous quarter. All variables are defined in Appendix A. Standard errors in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

controls (column 3), suggesting that bank controls did not crucially affect drawdown behavior. Indeed, none of the bank controls is statistically significant.

Including firm fixed effects does not change the magnitude of the estimated coefficient on the interaction term but does increase its statistical significance considerably.[32] The positive and significant interaction term suggests that low-cash-flow firms increase their credit line usage comparatively more (about 2.3 percentage points more) than high-cash-flow firms during the crisis, even after we control for observed and unobserved firm characteristics. Including bank controls does not affect the estimated coefficient on the interaction term. There is only weak evidence that firms draw down more from banks with low capital ratios.[33]

The control variables work as expected and many of the estimated coefficients are statistically significant. In particular, as shown in column 6, firms with larger cash holdings use less of their credit lines, whereas firms with high leverage show higher credit line usage. Similarly, lead bank controls work as expected, though many of the estimated coefficients are statistically insignificant. In particular, larger losses—proxied by net charge-offs—are associated with lower credit line usage.

To have a sense for the size of the impact of the liquidity shock, we use the coefficients in column 6 and calculate the incremental use of credit lines by low-cash-flow firms during the crisis. For the median total assets of $728 million in our sample, low-cash-flow firms draw down about $17 million more than their high-cash-flow counterparts. On aggregate, this amount represents about $4 billion of differentially larger drawdowns for low-cash-flow firms during the crisis.

In sum, the difference-in-difference regression results complement the evidence in Figure 4. Consistent with our main hypothesis, low-cash-flow firms draw on their credit lines more than their high-cash-flow counterparts. Credit line usage in general increased during the

[32]The coefficient (β_2) is stable across specifications, which suggests that our results are not driven by unobservable firm characteristics.

[33]This weak evidence is consistent with the aggregate data that suggest that bank health may have become salient only in 2008:Q4, which is therefore hard to detect in the data.

crisis and low-cash-flow firms increased their credit line usage comparatively more, suggesting that the liquidity insurance provided by credit lines becomes more relevant during the crisis.[34] There is however little evidence that bank health accounted for large parts of the credit line drawdowns.

3.4.2 Panel Approach

Our findings so far suggest that firms draw on their credit lines in response to adverse liquidity shocks, and the response is larger during the crisis, that is, in times when few other funding options are available. We now complement the difference-in-difference approach by using within-firm variation in cash flows as a measure of firm-level liquidity shocks. Specifically, we test whether firms recently experiencing a negative liquidity shock, which occurs when the firm's quarterly cash-flow-to-assets ratio is below the sample's average ratio over the sample period, draw more on their credit lines. According to our second testable prediction, credit lines are particularly valuable when aggregate liquidity is low, and hence, credit lines should be drawn on more intensely during the financial crisis.

We implement this approach using the following fixed-effect panel regression:

$$\begin{aligned} \textit{Drawdown Size}_{i,j,t} = c_i + \tau_{j,t} + \beta_1 \textit{ Liquidity Shock}_{i,t-1} \\ + \gamma \cdot X_{i,t-1} + \epsilon_{i,t}, \end{aligned} \tag{2}$$

where $\textit{Drawdown Size}_{i,j,t}$ is the amount drawn by firm i in industry j in quarter t divided by total assets in $t-1$. Our measure of $\textit{Liquidity Shock}_{i,t}$ at the firm level includes both the cash-flow-to-total-assets ratio and sales growth. In the fixed-effect regression, the liquidity shock variables are measured as deviations relative to the firm's means, and the identification of the coefficient is driven by within-firm variation. Hence, our interpretation of the coefficients on cash flow and sales growth as idiosyncratic shocks is plausible. Firm controls in $X_{i,t}$ include size, the ratio of tangible assets to

[34] In unreported regressions, we also examine the changes in firm cash flows and sales growth as alternative proxies for the liquidity shock. Our results are qualitatively similar.

total assets, the market-to-book (MTB) ratio, a dummy variable to account for missing MTB ratios, a dummy indicating whether the MTB ratio is greater than or equal to 8, leverage, and cash flow volatility.[35] We control for mergers and acquisitions with a dummy variable that is equal to 1 if quarter-to-quarter asset growth exceeds 25 percent.[36] We also include the following lead bank controls: tier 1 capital/RWA, ROA, share of core deposits in total assets, net charge-off ratio, and the indicator for missing bank variables. Finally, we include industry-time fixed effects $\tau_{j,t}$ to absorb industry-specific shocks. Our hypothesis is that negative deviations from the firm's average cash flow increase credit line drawdowns. We therefore expect β_1 to be negative and significant.

Table 3 presents our estimates of Equation (2). Consistent with our hypothesis, column 1 shows that the coefficient on deviations in firm-level cash-flow-to-total-assets ratio, our first measure of liquidity shock, has a strong negative effect on credit line drawdowns. A one-standard-deviation reduction in the quarterly cash-flow-to-total-assets ratio (0.041) increases credit line drawdowns by 0.08 percent of total assets.

We then turn to the second testable prediction that credit lines are particularly valuable when aggregate liquidity is low. To test this prediction, we augment Equation (2) and add the interaction between our liquidity shock measures and crisis, an indicator variable that is equal to 1 for the quarters from 2007:Q3 to 2008:Q4. We expect the coefficient on the interaction term to be negative and significant. Consistent with our hypothesis, the interaction term in column 2 is indeed negative and significant. The point estimate on the interaction term is larger than the linear effect shown in column 1 and implies that the positive effect on drawdowns doubles (0.16 percent of total assets), providing suggestive evidence that the liquidity insurance hypothesis was particularly important during the financial crisis. The point estimate remains almost unchanged when we add bank controls, providing further evidence that bank health

[35]Our sample includes a number of large tech companies with significantly large valuation numbers (MTB>8). This valuation may be the result of significant goodwill and intangible assets, and less related to capital expenditures and/or cash needs. The MTB>8 dummy accounts for these large-value firms separately.

[36]We find that changing this threshold to 10, 15, 20, and 30 percent does not affect our results.

Table 3. Regression Results: Drawdown Size

	Fixed-Effect Regression					
	(1)	**(2)**	**(3)**	**(4)**	**(5)**	**(6)**
Cash Flow/TA	–0.019*	–0.014	–0.015			
	(0.012)	(0.011)	(0.012)			
Cash Flow/TA * Crisis		–0.024**	–0.025***			
		(0.010)	(0.010)			
Sales Growth				–0.004***	–0.002*	–0.002*
				(0.001)	(0.001)	(0.001)
Sales Growth * Crisis					–0.004**	–0.004**
					(0.002)	(0.002)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	No	No	Yes	No	No	Yes
Industry-Time FEs	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.057	0.058	0.058	0.059	0.059	0.060
Number of Obs.	7,704	7,704	7,704	7,704	7,704	7,704

Note: This table summarizes fixed-effect panel regression results with drawdown size at time t as the dependent variable. Sales growth is measured as the quarterly change in sales divided by previous-quarter sales. *Crisis* is a dummy variable equal to 1 for the 2007:Q3–2008:Q4 period. Additional firm controls are size (log of total assets), cash/assets, market-to-book (MTB) ratio, a dummy variable for firms missing MTB ratio that takes the value of 1 when the firm does not report market capitalization, tangible assets/assets, leverage, used credit line/available credit line as a measure of remaining debt capacity, a dummy variable for firms with market-to-book ratio greater than or equal to 8, cash flow volatility, and a merger and acquisition (M&A) dummy variable that takes the value of 1 when the quarterly growth in total assets is greater than or equal to 25 percent. Bank controls are taken from the lead bank and include the total capital ratio, return on assets, core deposit ratio, net charge-off ratio, and missing bank indicator. High capital is an indicator that is equal to 1 if the lead banks' capital ratio is above the sample median. All variables are defined in Appendix A. All independent variables are lagged one period. We include industry-time and firm fixed effects. Robust standard errors are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

was not the primary driver of credit line drawdowns during the crisis.[37] Our result on the importance of cash flow for U.S. public firms is consistent with international survey data from the financial Crisis (Campello et al. 2011).

[37]Although the coefficient on Cash Flow/TA in columns 2 and 3 is not significant at conventional levels, the sum of that coefficient and the coefficient on its interaction with Crisis is significant at the 1 percent level in both cases (F-statistics are 7.95 and 8.79, respectively).

To ensure that our results are robust to the use of an alternative measure of liquidity shock, we repeat this analysis with firm-level sales growth. Columns 4 through 6 show the results. Both the linear term, column 4, and the interaction term with Crisis, columns 5 and 6, are negative and significant. These regressions also yield similar results in terms of economic importance. A one-standard-deviation reduction in sales growth (0.219) increases credit line drawdowns by about 0.13 percent of assets during the crisis.

These results are robust to accounting for the financial conditions of the firm's lead bank. Columns 3 and 6, which include lead bank controls, show that the point estimates on the interactions of Cash Flow and Sales Growth with the crisis dummy are statistically significant and remain almost unchanged, indicating that the time-varying bank heterogeneity is not driving our results. We further investigate the role of the lead bank's financial health on drawdown decisions during the financial crisis, beyond bank controls, and do not find evidence for bank health driving our results. In Figure D.1 in Appendix D, we show that drawdowns at lead banks that failed during the financial crisis do not differ from drawdowns at other lead banks. In addition, Table D.3 in Appendix D shows that firms did not draw differentially more from weaker banks, namely, banks that entered the crisis with low capital or high short-term wholesale funding dependence, which indicates that credit line drawdowns during the financial crisis did not reflect firms' concerns about the financial health of their lenders.[38]

3.4.3 Drawdowns by Firm Characteristics

Next, we assess whether the liquidity insurance hypothesis is particularly important for financially constrained firms. Using three subsample splits that are commonly used when assessing financing constraints—bond rating, dividend payer status, and size—we estimate Equation (2) in each subsample.

Table 4 shows the results of the subsample analysis. Columns 1 through 4 show the results by bond rating. The effect of cash flow

[38] Although we cannot rule out that drawdowns right after the failure of Lehman Brothers reflected bank health concerns, that effect would have been short-lived and dominated by cash flow concerns throughout the financial crisis.

Table 4. Regression Results: Drawdown Size by Firm Type

	Bond Rating				Dividend Payer				Size			
	Non-investment		Investment		Yes		No		Small		Large	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Cash Flow/TA	–0.020*	–0.014	–0.018	–0.021	–0.008	–0.005	–0.029*	–0.023	–0.027**	–0.021*	–0.037	–0.030
	(0.012)	(0.012)	(0.032)	(0.040)	(0.017)	(0.018)	(0.016)	(0.015)	(0.012)	(0.012)	(0.025)	(0.024)
Cash Flow/TA * Crisis		–0.029***		0.010		–0.009		–0.039**		–0.030***		–0.036
		(0.010)		(0.042)		(0.013)		(0.017)		(0.010)		(0.034)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Time FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.062	0.063	–0.048	–0.049	0.062	0.062	0.068	0.070	0.054	0.055	0.076	0.076
Number of Obs.	6,699	6,699	889	889	4,141	4,141	3,537	3,537	3,708	3,708	3,946	3,946

Note: This table summarizes fixed-effect panel regression results with drawdown size at time t as the dependent variable. Sales growth is measured as the quarterly change in sales divided by previous-quarter sales. Crisis is a dummy variable equal to 1 for the 2007:Q3–2008:Q4 period. Additional controls are size (log of total assets), cash/assets, market-to-book (MTB) ratio, a dummy variable for firms missing MTB ratio that takes the value of 1 when the firm does not report market capitalization, tangible assets/assets, leverage, used credit line/available credit line as a measure of remaining debt capacity, a dummy variable for firms with market-to-book ratio greater than or equal to 8, cash flow volatility, and a merger and acquisition (M&A) dummy variable that takes the value of 1 when the quarterly growth in total assets is greater than or equal to 25 percent. Bank controls are taken from the lead bank and include the total capital ratio, return on assets, core deposit ratio, net charge-off ratio, and missing bank indicator. All variables are defined in Appendix A. All independent variables are lagged one period. We include time effects for each and every quarter. Standard errors double-clustered by industry-time and firm in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

shocks is concentrated in firms with non-investment-grade rating (which include non-rated firms), typically considered more financially constrained. For these firms, one-standard-deviation reduction in cash flows (0.044) increases drawdowns by about 0.1 percent of assets. The effect almost doubles during the financial crisis. For their investment-grade counterparts, we find no statistically significant effect of cash flow shocks on drawdowns. The point estimate on the interaction of Cash Flow and Crisis is positive, albeit insignificant. The results on investment-grade firms should be treated with some caution, as only a small share of firms in our sample have an investment-grade rating, and these firms draw less on their credit lines in general.

Columns 5 through 8 show the results for subsamples by dividend payer status. Firms that do not pay dividends are generally more financially constrained. Similar to the bond rating results, the effects are concentrated in the subsample of firms that do not pay dividends, even so both subsamples exhibit the same standard deviation in drawdowns (1.5 percent of assets). For firms that do not pay dividends, a one-standard-deviation reduction in cash flows (0.031) increases credit line drawdowns by almost 0.1 percent of total assets. The effect also doubles during the crisis. Finally, the size measure of financing constraints, small firms being more constrained, shown in columns 9 through 12 exhibits a more nuanced pattern. While the point estimate for large firms is larger than the point estimate for small firms in the specification without interaction (columns 9 and 11), the effect during the financial crisis is concentrated in small firms (columns 10 and 12). Both groups have about the same standard deviation in drawdowns (1.5 percent of assets), making the economic magnitudes directly comparable. For small firms, a one-standard-deviation reduction in cash flows (0.053) increases drawdowns by 0.14 percent of total assets. The effect also doubles during the financial crisis.

In sum, using across- and within-firm variation, and different measures of idiosyncratic and aggregate liquidity shocks, we provide empirical evidence for the first and second predictions of the liquidity insurance hypothesis: (i) firms draw on credit lines to smooth liquidity shocks and (ii) firms draw even more during times of low aggregate liquidity such as the financial crisis. Consistent with liquidity insurance being crucial for otherwise financially constrained firms

during the crisis, we find that the effects are concentrated in the subset of financially constrained firms.

4. Real Effects of Credit Line Drawdowns

In this section, we assess the real effects of credit line drawdowns. We first present graphical evidence that links credit line drawdowns to investment. We then discuss potential endogeneity concerns when considering the relationship between drawdowns and investment. Next, we estimate cross-sectional and panel regression specifications and account for the likely endogeneity of credit line drawdowns. Last, we assess whether drawdowns during the crisis increased cash holdings.

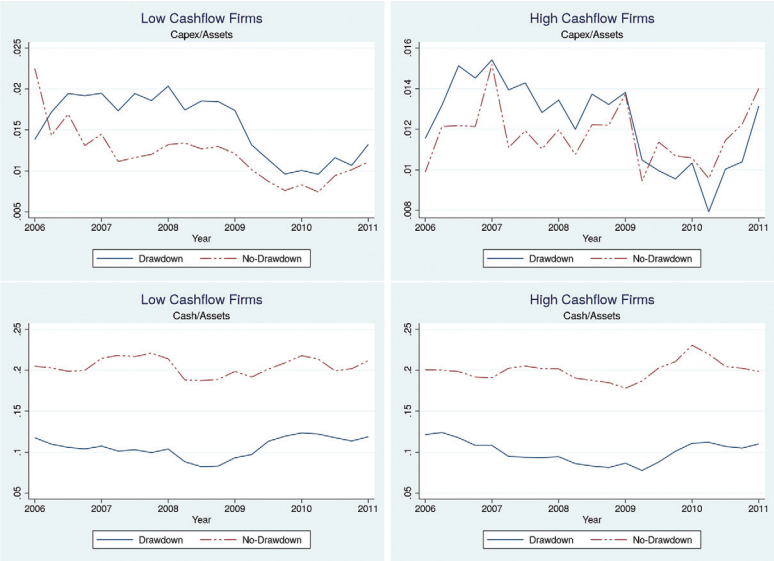
4.1 Graphical Evidence

One key rationale for firms to contract a credit line facility is to have on-demand access for financing their investment needs, particularly in the face of adverse liquidity shocks such as unexpectedly low cash flows (Holmström and Tirole 2000). More generally, investment activities depend on investment opportunities and on the firm's ability to capitalize on them. A positive association of credit line drawdowns with investment therefore indicates that the ability to draw on credit lines *facilitates* investment when the opportunity arises. The third key prediction associated with the liquidity insurance hypothesis therefore is that firms use proceeds from credit line drawdowns to maintain current investment or to seize new investment opportunities. Hence, drawdowns should have real effects.

As discussed above, low-cash-flow firms tried to maintain their investment spending almost as much as the high-cash-flow firms, and they did so precisely when their drawdowns were comparatively larger than the drawdowns of their high-cash-flow counterparts (Figure 4). Of course, not all the low-cash-flow firms may have been able to tap their credit lines to obtain the liquidity necessary to continue operations. For example, pre-established covenants in the credit line contract may have restricted the availability of funds.

To better understand firms' drawdown behavior during the crisis, we further split firms in our sample by cash flow and according

Figure 6. Investment Spending and Cash Holdings of Low- and High-Cash-Flow Firms by Drawdown



Note: Cash/Assets and Capex/Assets are the average ratio of cash and capital expenditures to total assets, respectively. Firm with below (above) median change in operating margin from pre-crisis to crisis are "low-cash-flow" ("high-cash-flow") firms. Cash, capex, and total assets are taken from Compustat. Credit line information is collected from SEC 10-Ks and 10-Qs.

to whether they were able to draw on their credit lines (drawdown versus no-drawdown firms). The upper two panels of Figure 6 show this four-way split for capital expenditures. For low-cash-flow firms, shown in the upper left panel, there is a large difference in investment spending between firms that drew on their credit lines (the solid line) and firms that did not use their credit line (the dashed line). For high-cash-flow firms, shown in the upper right panel, there is no visible difference between drawdown and no-drawdown firms. This pattern is consistent with the regression analysis in Section 3.4 that shows that less financially constrained firms (investment-grade rated, dividend payer, and large) did not change their drawdown behavior during the financial crisis. More generally, firms generating high cash flow and able to self-finance may use drawdowns for reasons other than general corporate purposes.

One concern with this graphical evidence is that the correlation between drawdowns and capital expenditures could be spurious, and thus drawdowns could have been used as precautionary cash buffers. The bottom left panel shows that low-cash-flow firms able to draw their lines and no-drawdown firms also reduced their cash holdings. The bottom right panel exhibits a similar but attenuated pattern. Note in the lower panels that no-drawdown firms have to rely more on their cash holdings generally and thus the cash-to-total-assets ratio is larger for these firms. Hence, the generally lower cash holdings across all groups suggest that drawdowns were not used to increase cash buffers or to hoard cash.

4.2 Empirical Approach

Having shown graphical evidence indicating that credit line drawdowns are used to finance investment in response to liquidity shocks, we now discuss our empirical strategy that moves us closer to a causal interpretation. We first discuss the OLS approach and its shortcomings. We then motivate credit line availability as a plausible instrument for drawdowns. Last, we discuss the first stage of the instrumental-variable approach.

4.2.1 Cross-Sectional Analysis

$$\Delta Investment_i = \beta_1 \cdot Drawdown\ Size_{i,crisis} + \gamma \cdot X_{i,pre-crisis} + \epsilon_i, \quad (3)$$

where $\Delta Investment$ is defined as the change in the average ratio of capital expenditures to total assets from the pre-crisis period (2005:Q4 and 2007:Q1) to the crisis period (2007:Q3 and 2008:Q4); *Drawdown Size* is the size of drawdown relative to total assets over the crisis period. Vector $X_{i,pre-crisis}$ includes firm controls such as size, the ratio of tangible assets to total assets, the MTB ratio, leverage, cash flow volatility, sales growth, and operating margin, all of which are measured as averages in the pre-crisis period. We also include industry effects. Since credit lines work as liquidity insurance, we expect the coefficient on drawdown to be positive and significant ($\beta_1 > 0$). A key concern with this specification, however, is the potential endogeneity of drawdowns. A firm may decide to draw their credit line after experiencing an adverse liquidity shock, foreseeing the need for additional liquidity to finance capital expenditures.

4.2.2 Motivation for an Instrumental-Variable Strategy

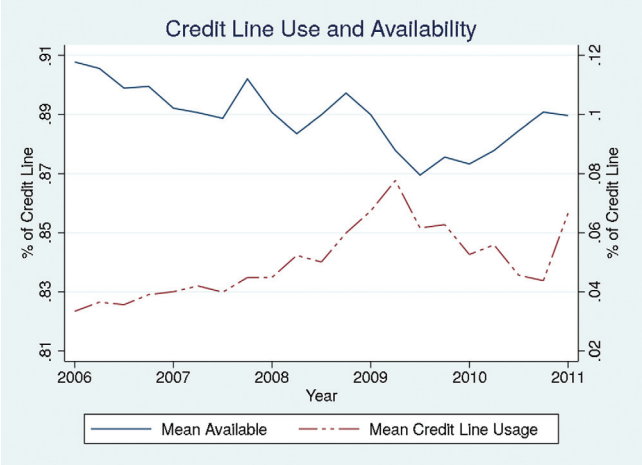
Building on previous work in the investment literature, our approach in assessing the effect of drawdowns on investment spending relies on the role of pre-determined financing constraints. Instead of using covenant breaches, which were rare and often waived during the financial crisis (Bird et al. 2022) as an instrumental variable for drawdowns, we rely on a unique institutional feature of credit facilities that limits a firm's access to the credit line funds, and propose it as a novel measure. We call this financing constraint measure credit line availability, defined as the ratio of the credit line available to the firms divided by their total assets. To be clear, credit line availability only reflects the maximum borrowing limit and is governed by pre-determined contractual clauses, such as base formulas or minimum financial ratios, which in many cases are out of the firm's control or exceed its bargaining power. Previous work in the literature treats covenants and their breaches as exogenous in the same way we treat availability and its changes as exogenous.[39] Therefore, availability can be reduced based on collateral formulas well before a covenant is breached.

Figure 7 plots average credit line use and percent of total revolving lines available over our sample period. Despite the significant increase in credit line drawdowns during the financial crisis, a cross-firm analysis of our data shows that not all firms had full access to their credit lines. The percentage of credit line used (dashed line) mimics the aggregate drawdown pattern. Average credit line limit available to firms (solid line) is about 90 percent at the beginning of the sample. It declines early in the crisis, recovers, and then falls again in the wake of the Lehman failure. This evidence suggests that our measure picks up the tightening of financing constraints during the crisis.

Credit line availability reflects credit supply factors and a type of financing constraint that became particularly relevant during the financial crisis. This definition is more nuanced than the one of Chava and Roberts (2008), who identify financing constraints as

[39]Murfin (2012) shows that banks write tighter contracts after suffering defaults on their loan portfolios and therefore covenants can be seen as exogenous to the firm. From a firm's perspective, tight covenants are similar to a reduction in credit supply, as they induce financing constraints.

Figure 7. Credit Lines Usage and Availability



Note: Credit line use is the average ratio of the amount of credit line used to the total revolving line in our sample of 470 firms. Credit line availability is the fraction of the credit line that can be accessed divided by the total revolving line. A detailed description is provided in Appendix A. Credit line information is collected from SEC 10-Ks and 10-Qs. Total assets are taken from Compustat.

situations when firms breach contract covenants. If a covenant is breached, lenders can legally stop financing the firm and demand immediate repayment of the debt in full. In order to continue borrowing, the firm must negotiate a waiver, potentially subject to penalties, including a waiver fee, higher interest rates, or increased collateral. In comparison, our measure includes contractually defined automatic reductions in the firm's debt capacity, which in general are not waived. Our credit availability measure is therefore closer to measures of covenant tightness, also attributed to credit supply conditions (Murfin 2012).

One key advantage of credit line availability is that it varies from quarter to quarter, and thus it is a continuous measure, allowing us to pick up the tightening of constraints rather than the effect of a relatively rare and discrete breach. Consistent with the low enforcement of contractual breaches in Bird et al. (2022), only 3 percent of observations in our sample exhibit a covenant breach. Given the systematic nature of covenant breaches during the financial crisis, we observe many instances in which a covenant breach was waived and

yet credit availability was reduced.[40] In our data, these events appear as reductions in availability without a covenant breach. Therefore, in our view, studying the role of financing constraints during the crisis calls for alternative measures to covenant breaches. Moreover, contractually defined credit line availability offers a measure not affected by waivers.

To support its exogeneity and thus the plausibility of credit line availability as an instrument, we analyze the response of credit line availability to covenant breaches. The top panel of Figure 8 shows the average availability and the share of observations with a covenant breach in our sample. As expected, average availability is lower when more firms breach covenants, and the figure shows that this is in fact the case in our data. Further, this pattern suggests that availability as defined in the credit facility contract is a proxy for the intensity of financing constraints. The bottom panel of Figure 8 shows that changes in average line availability are mainly driven by firms that breach covenants. For firms without breaches, credit line availability remains essentially unchanged. In Appendix D, we provide supplementary evidence showing that, on average, credit line availability falls by about 5 percentage points after a covenant breach.

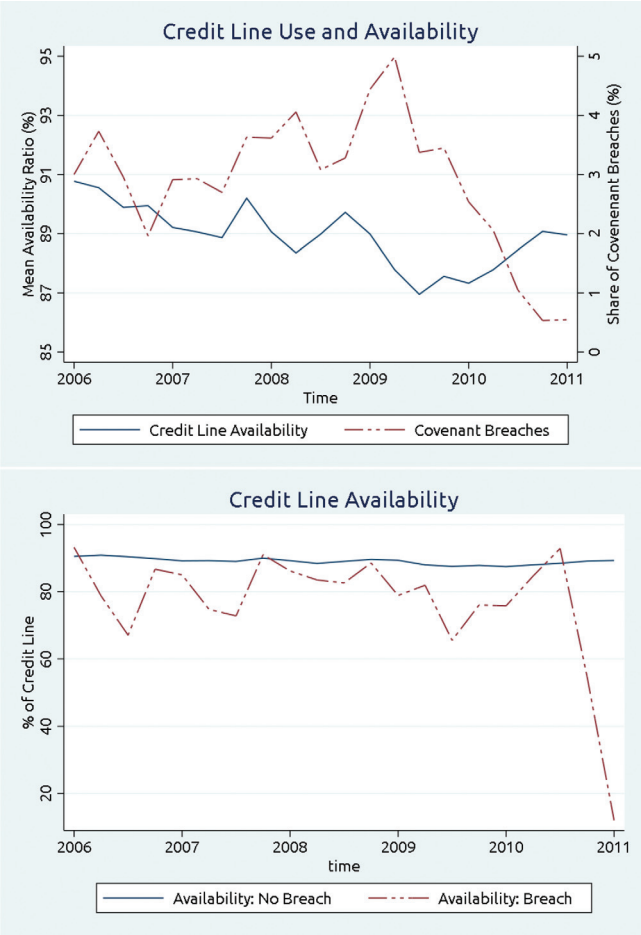
For credit line availability to be a good proxy for financing constraints and a strong instrument for credit line drawdowns, we need sufficient cross-sectional heterogeneity as well as within-firm variation. Figure 9 shows the percentiles of credit line availability throughout the sample period. There is significant variation in the cross-section of firms.

4.2.3 First Stage of the Instrumental-Variable (IV) Approach

To address endogeneity concerns, we therefore instrument drawdowns with credit line availability, our proposed measure of financing constraint. A key identification assumption is that the availability ratio pre-crisis is exogenous to capital expenditures during the crisis period and only affects capital expenditures during the crisis period through its effect on drawdowns in crisis period. Intuitively, the less

[40] Anecdotal evidence from SEC filings, available upon request, shows frequent bank waivers on covenant breaches and subsequent restrictions on credit line availability.

Figure 8. Credit Line Availability and Covenant Breaches

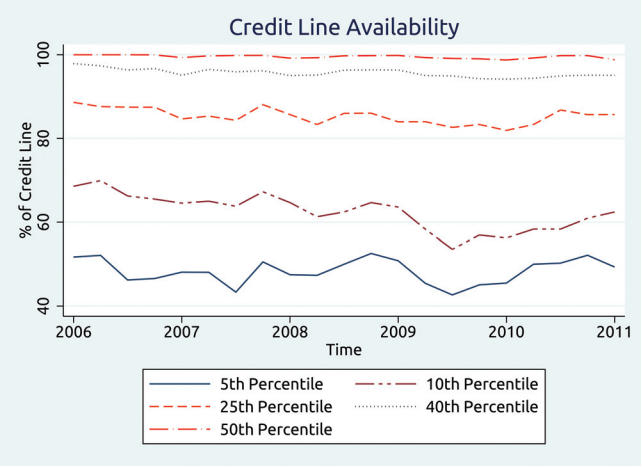


Note: Credit line availability is the fraction of the credit line that can be accessed divided by the total revolving line. Share of covenant breaches is the fraction of firms in breach of a covenant in a given quarter. Credit line and covenant breach information is collected from SEC 10-Ks and 10-Qs.

credit available on the credit line, the more financially constrained the firm is:

$$\begin{aligned} \textit{Drawdown Size}_{i,crisis} = \beta_1 \textit{Credit Line Availability}_{i,pre\text{-}crisis} \\ + \gamma \cdot X_{i,pre\text{-}crisis} + \epsilon_i, \end{aligned} \tag{4}$$

Figure 9. Credit Line Availability by Percentile



Note: Credit line availability is the fraction of the credit line that can be accessed divided by the total revolving line. A detailed description is provided in Appendix A. Credit line information is collected from SEC 10-Ks and 10-Qs.

where credit line availability is measured as the ratio of credit line available to total assets. If credit line availability measures financing constraints, then β_1 should be positive and significant.

4.2.4 Panel Analysis

We also estimate the correlation between credit line drawdowns and investment using the following panel regression:

$$\begin{aligned} Investment_{i,t} = c_i + \tau_t + \beta_1 \cdot Drawdown\ Size_{i,t-1} \\ + \beta_2 \cdot Drawdown\ Size_{i,t-1} \times Crisis_t \\ + \gamma \cdot X_{i,t-1} + \epsilon_{i,t}, \end{aligned} \tag{5}$$

where *Investment* is defined as the ratio of capital expenditures to total assets, *Drawdown Size* is the size of drawdown relative to total assets, and *Crisis* is an indicator variable that takes the value of 1 between 2007:Q3 and 2008:Q4, and 0 otherwise. Since credit lines work as liquidity insurance, we expect the coefficient on drawdown to be positive and significant ($\beta_1 > 0$). To assess whether the

effects are larger during the crisis—that is, in times of low aggregate liquidity—we also add an interaction term between Drawdown Size and Crisis indicator variable. We expect the coefficient on the interaction term to be positive and significant as well ($\beta_2 > 0$).

Again, we address endogeneity concerns instrumenting drawdowns with credit line availability. Unconstrained firms—those whose credit line is fully available—are expected to behave differently. Thus, we use an additional dummy variable to control for a potential nonlinear effect around full availability, separately. To estimate the drawdown size in the first stage of our instrumental-variable regression, we therefore include both the credit line availability ratio and an indicator for full availability as instruments:

$$\begin{aligned} \textit{Drawdown Size}_{i,t-1} = c_i + \tau_t + \beta_1 \textit{Credit Line Availability}_{i,t-2} \\ + \beta_2 \textit{ Full Availability}_{i,t-2} + \gamma \cdot X_{i,t-1} + \epsilon_{i,t}. \end{aligned} \tag{6}$$

As in the cross-section, we expect β_1 to be positive and significant. Firms with full availability should be unconstrained and therefore expected to rely comparatively less on credit lines than constrained firms. Hence, β_2 is expected to be negative and significant. We include the MTB ratio, sales growth, and the operating margin as a proxy for investment opportunities. As before, we include size, the cash-flow-to-total-assets ratio, the ratio of tangible assets total assets, a dummy to account for missing MTB ratios, a dummy for whether the MTB ratio is greater than or equal to 8, cash flow volatility, and leverage as additional control variables. We also include the lead banks' tier 1 capital/RWA ratio, ROA, share of core deposits in total assets, net charge-off ratio, and the indicator for missing bank variables as additional controls. We also include the dummy variable that controls for mergers and acquisitions, and industry-time fixed effects to account for industry-specific shocks.

4.3 Cross-Sectional Evidence—Investment

We now test whether drawdowns and investment are positively related in the cross-section and then estimate the IV regressions with Equation (4) as first stage.

Table 5. Capital Expenditures: Cross-Sectional Evidence

		Instrumental Variable			
	OLS (1)	**First-Stage Availability (2)**	**Second-Stage Availability (3)**	**First-Stage Committed (4)**	**Second-Stage Committed (5)**
Drawdown Size	0.019***		0.056*		0.037
	(0.007)		(0.030)		(0.033)
Pre-crisis Availability/TA		0.121***			
		(0.032)			
Pre-crisis Committed/TA				0.083***	
				(0.025)	
Firm Controls	Yes	Yes	Yes	Yes	Yes
Industry FEs	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.059		–0.111		–0.016
F-Statistic			14.47		10.86
Number of Obs.	453	451	451	451	451

Note: This table summarizes cross-sectional regression results with change in the average capital expenditure ratio from pre-crisis (2005:Q4–2007:Q1) to crisis (2007:Q3–2008:Q4) as the dependent variable. The capital expenditure ratio is measured as the ratio of capital expenditures to total assets. All regressions include the following additional controls (pre-crisis averages): cash flow, sales growth, size (measured as the natural log of total assets), market-to-book ratio, leverage, tangible asset ratio, and cash flow volatility. Robust standard errors in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table 5 shows the cross-sectional OLS and IV results. We find a positive and statistically significant correlation between credit line drawdowns and investment (column 1). To be closer to a causal interpretation of this correlation, we instrument credit line drawdowns with credit line availability in the pre-crisis period—namely, we account for financing constraints using the firm's ability to draw on their credit lines in the pre-crisis period. We measure pre-crisis availability as the average availability ratio between 2005:Q4 and 2007:Q1. Column 2 shows that pre-crisis availability is a strong predictor of credit line drawdowns. As expected, the effect is positive, showing that firms with more pre-crisis available funds managed to draw down more. The F-statistic on the instrument is above 14. The second-stage estimates, shown in column 3, confirm that drawdowns were used to maintain investment spending. The coefficient is significantly larger, almost three times bigger than in the OLS regression, suggesting that the OLS coefficient suffers from attenuation bias, considering that not all the firms were able to draw on their

credit lines. Our estimates in column 3 suggest that a one-standard-deviation increase in drawdowns (8.2 percent in the cross-section) is associated with a 25 percent increase in capital expenditures during the crisis (an increase in the average capital expenditure ratio from 1.52 percent to 1.9 percent).

Column 4 shows our estimates using an alternative instrument—the ratio of pre-crisis committed credit lines to total assets—as a measure of the firm's debt capacity in the pre-crisis period (average between 2005:Q4 and 2007:Q1). This instrument is also positively related to drawdowns, but is somewhat weaker than credit line availability. The F-statistic on this first stage is just above 10. While the coefficient on drawdowns in the second stage, shown in column 5, is positive and twice the size of the OLS coefficient, it is not statistically significant. One reason for this result is that, just as in the OLS regression, the committed credit line does not account for how much the firm can effectively access its credit line funds. As such, the result suggests that credit line availability is, in the context of our study, a more plausible instrument.

4.4 Panel Evidence—Investment

In this section, we explore the relationship between drawdowns and investment, using the within-firm variation in our data. Using the panel dimension also allows us to conduct a subsample analysis, which we report in the next section.

We start by estimating the correlation between credit line drawdowns and investment in the panel. We then use credit line availability as an instrument for credit line drawdowns to move closer to a causal interpretation of the effect of the liquidity insurance provided by credit lines. Here a key identification assumption is that the availability ratio in $t-2$ is exogenous to capital expenditures in t and only affects capital expenditures in t through drawdowns in the previous quarter $(t-1)$. We find that the availability ratio in $t-2$ has a low correlation with capital expenditures scaled by total assets in t (the correlation coefficient is –0.08), indicating that the exclusion restriction holds in the panel.

Table 6 reports both our OLS estimates and the IV estimates of Equation (5). Our OLS fixed-effect specifications, columns 1 and 2, show that the effect of drawdowns on capital expenditures

Table 6. Regression Results: Capital Expenditures

	Fixed-Effect Panel Regression		Fixed-Effect Panel IV Regression			
	OLS (1)	**OLS (2)**	**First Stage (3)**	**Second Stage (4)**	**First Stage (5)**	**Second Stage (6)**
Drawdown Size (Lagged)	0.027***	0.027**		0.103		–0.069
	(0.009)	(0.011)		(0.091)		(0.113)
Drawdown Size * Crisis		0.001				0.461***
		(0.017)				(0.174)
Availability Ratio			0.043***		0.039***	
			(0.006)		(0.006)	
Availability Ratio * Crisis					0.013**	
					(0.006)	
Full Availability			–0.002***		–0.003***	
			(0.001)		(0.001)	
Full Availability * Crisis					0.001	
					(0.001)	
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Time FEs	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.686	0.686		0.010		–0.113
F-Statistic				34.964		14.232
Number of Obs.	7,704	7,704	7,704	7,704	7,704	7,704

Note: This table summarizes fixed-effect panel regression results with capital expenditure at time t as the dependent variable. Capital expenditure is measured as the ratio of capital expenditures to total assets. *Crisis* is a dummy variable equal to 1 for the 2007:Q3–2008:Q4 period. Size is measured as the natural log of total assets, and MTB is market-to-book ratio. We also include a dummy variable for firms that do not report market capitalization (missing MTB), and those with MTB ratio greater than or equal to 8, cash flow volatility, and a merger and acquisition (M&A) dummy variable that takes the value of 1 when the quarterly growth in total assets is greater than or equal to 25 percent. Bank controls are taken from the lead bank and include the total capital ratio, return on assets, core deposit ratio, net charge-off ratio, and missing bank indicator. All variables are defined in Appendix A. All independent variables are lagged one period. We include time effects for each and every quarter. Standard errors double-clustered by industry-time and firm in parentheses. *$p < 0.10$, ** $p < 0.05$, ***$p < 0.01$.

is large, positive, and significant, suggesting that credit line drawdowns increase capital expenditures (column 1). To provide the economic significance of our results, we consider an increase in the size of drawdowns equal to one standard deviation (about 1.5 percent). Our estimated coefficient of 0.027 indicates that, as a result of this change in drawdowns, the average capital expenditure as a percent of total assets increases by about 0.04 percent. Taking into account that the average capital expenditure ratio for firms that have credit lines in our sample is 1.3 percent of total assets, the predicted change in drawdowns is associated with an increase in capital expenditures of about 3 percent (0.0004/0.013).

In column 2, we report the results when we add the interaction of Drawdown Size and Crisis. The coefficient on the interaction term is positive but insignificant, suggesting no additional effect of credit line drawdowns on investment spending during the financial crisis. This finding goes against our hypothesis that liquidity insurance is particularly important during times of low aggregate liquidity. However, a crucial reason why the OLS estimate is potentially biased is that during crisis times access to the credit line becomes more salient, as other funding sources typically dry up. If financially constrained firms, most in need of credit line funds, cannot access their funding, the OLS estimate will be biased toward zero.[41] Hence, using credit line availability as instrument for drawdowns is necessary to estimate the relation between drawdowns and investment.

Table 6, columns 3 through 6, presents our estimates using the IV approach, with Equation (6) as the first stage. Column 3 shows that credit line availability is a strong predictor of credit line drawdowns (t-statistic over 10). Firms with high credit line availability draw more on their lines. As suggested, firms with full availability rely less on their credit lines and thus the effect is negative and statistically significant at the 1 percent level. The F-statistic on the instrument in the first stage is almost 35, indicating strong instruments.

The economic effect of credit line availability on drawdowns is large. The point estimate implies that a one-standard-deviation

[41] In the next section, we show that the results are particularly strong for the groups of firms that are traditionally thought of as financially constrained.

increase in the availability ratio (0.1) increases the size of the drawdown by 0.4 percent, about a third of its standard deviation. While contractually determined, credit line availability limits drawdowns but does not limit investment opportunities or investment spending out of cash flows. As such, the instrument recovers credit supply induced heterogeneity in credit line drawdowns in response to liquidity shocks.[42]

Column 4 reports the second-stage results, that is, the estimated effect of instrumented credit line drawdowns on investment. The coefficient on drawdowns is positive and considerably larger than in the fixed-effect panel regression, though not statistically significant at conventional levels.[43] A one-standard-deviation increase in drawdowns is now associated with a 12 percent increase in capital expenditures (0.2 percent of total assets), which is large when compared with average capital expenditures of 1.3 percent of assets.[44] The larger estimated effect in the instrumental-variable approach likely reflects heterogeneous responses to the liquidity shocks depending on the availability of funds at the firm level. For illustration, consider two firms, one with zero availability and the other with high availability, that are otherwise identical. After a negative liquidity shock, both firms would seek to draw their credit lines instead of depleting their cash reserves to finance investment. Our results suggest that only the firm with high availability can do that. The firm with no line availability must use cash to support its investment plans. In this case, the OLS estimate of the average effect of drawdowns across both firms is biased downward. The instrumental-variable approach recovers the full effect from the firm with high availability.

Column 5 shows the results of the first-stage regression with crisis interaction terms as additional instruments. Balli and Sorensen

[42]In Appendix D, we also show that using an indicator variable for covenant breaches does not predict drawdowns, suggesting that using a continuous measure of the intensity of treatment is more important.

[43]We obtain a marginally significant estimate using separate industry and time fixed effects (FEs). The inclusion of industry $\times$ time FE, a very demanding specification, reduces the significance (the p-value is 0.13).

[44]In complementary, unreported regressions, we find similar results if we exclude credit line repayments and thus consider only positive drawdowns. We also test whether drawdowns are used to finance inventories. We cannot confirm a positive association between drawdowns and inventories.

(2013) show that interaction terms of the instruments with the exogenous variable (Credit Line Availability * Crisis, Full Availability * Crisis) are valid instruments for the interaction with an endogenous variable (Drawdown Size * Crisis). We find that the effect for credit line availability interacted with crisis is highly significant, while the interaction of Full Availability and Crisis is not. However, with an F-statistic of 14, the first stage remains highly predictive of drawdowns.

The corresponding second stage, in column 6, shows that the effects of credit line drawdowns are concentrated in the financial crisis period. This result is intuitive, as our instruments recover the underlying heterogeneity in financing constraints that become particularly relevant during the crisis. Firms with low credit line availability were not able to draw and exhibit lower investment rates due to financing constraints. The point estimate on the interaction of Drawdown Size and Crisis is more than four times larger than the linear effect shown in column 4 and implies a 45 percent increase in average capital expenditures (0.6 percent of total assets).[45]

One additional concern with the previous specification is that the definition of crisis could raise another endogeneity issue. For instance, firms could have adjusted their expectations about the freeze of the asset-backed commercial paper market in fall 2007. While our graphical evidence suggests that expectations and policies only shifted after the failure of Lehman Brothers, for robustness purposes, we consider two measures of aggregate liquidity shocks, in addition to our crisis dummy: the TED (LIBOR-Treasury) spread and the tightening of lending standards from the Senior Loan Officer Opinion Survey (SLOOS). Using these measures yields similar results. We also find similar results when using changes in property, plant, and equipment (PPE) instead of capital expenditures as the dependent variable, though we only find a larger effect on PPE in the regression without the Crisis interaction. The Crisis interaction, however, is only half the size and insignificant. We provide these results and more details in Appendix D (Table D.2).

[45] Although the coefficient of drawdowns in column 6 is not significant, the sum of that coefficient and the coefficient on the interaction of Drawdown Size and Crisis is positive and significant at the 1 percent level (F-statistic is 31.5).

In sum, the regression results suggest that financing constraints play a crucial role for firms consistent with the liquidity insurance hypothesis. When firms can take advantage of this insurance mechanism after experiencing an adverse liquidity shock, they manage to sustain their investment plans.

4.5 Subsample Analysis—Investment

Next, we conduct a subsample analysis. Specifically, we expect the effects of credit line drawdowns on investment to be pronounced for the firms that, even under normal market conditions, are considered to be financially constrained. As explained above, financially constrained firms are the group for which the instrument is most salient during the crisis. As such, the effect of changes in credit line availability should be larger for firms that have few options but to rely on their credit facilities to smooth the impact of financial shocks. We therefore split the sample by commonly used proxies for financing constraints: (i) cash flow (low and high), (ii) bond ratings (investment-grade and non-investment-grade firms), (iii) dividend-paying status, and (iv) size (small and large firms). Perhaps surprisingly, drawdowns and their standard deviation are about the same across groups, with the exception of investment-grade rated firms, for which drawdowns are smaller. For each of these sample splits, we report only the second-stage results of our instrumental-variable approach, in parallel to Table 6, columns 4 and 6, and report the corresponding first stage F-statistic in the respective second-stage result column.

Table 7, panel A, columns 1 through 4, shows the results for low- and high-cash-flow firms. As in Section 3.2, we define firms with a large drop in operating margin between pre-crisis and crisis (above the median drop) as low-cash-flow firms, and those with a small drop in operating margin (below the median drop) as high-cash-flow firms. The regression results for the subsample of low-cash-flow firms (columns 1 and 2) are almost identical to the results in the full sample (table 6, columns 4 and 6), suggesting that the results reported above are driven by the firms most likely in need of liquidity during the financial crisis. In contrast, we do not find significant effects for the subsample of high-cash-flow firms (columns 3 and 4).

Table 7. Capital Expenditures: Subsample Analysis

	Panel A							
	Cash Flow				Bond Rating			
	Low		High		Non-investment		Investment	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drawdown Size	0.119	–0.075	0.092	0.124	0.126	–0.055	–0.035	–0.306*
(Lagged)	(0.143)	(0.173)	(0.064)	(0.141)	(0.096)	(0.118)	(0.069)	(0.176)
Drawdown Size *		0.528**		–0.071		0.474**		0.594*
Crisis		(0.223)		(0.320)		(0.186)		(0.302)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Time FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.011	–0.137	0.011	0.006	0.001	–0.127	0.045	–0.220
F-Statistic	17.526	7.372	26.689	4.645	33.269	13.220	8.642	2.140
Number of Obs.	3,816	3,816	3,831	3,831	6,699	6,699	889	889
	Panel B							
	Dividend Payer				Size			
	Yes		No		Small		Large	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drawdown Size	0.215*	0.065	–0.030	–0.182	–0.094	–0.243	0.233*	0.022
(Lagged)	(0.119)	(0.146)	(0.109)	(0.167)	(0.110)	(0.156)	(0.129)	(0.131)
Drawdown Size *		0.375*		0.438		0.536*		0.578**
Crisis		(0.195)		(0.318)		(0.279)		(0.253)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Time FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	–0.044	–0.109	0.013	–0.094	–0.005	–0.143	–0.129	–0.390
F-Statistic	31.240	12.133	16.216	4.121	26.778	9.953	20.471	10.002
Number of Obs.	4,141	4,141	3,537	3,537	3,708	3,708	3,946	3,946

Note: This table summarizes fixed-effect panel regression results with capital expenditure at time t as the dependent variable. Capital expenditure is measured as the ratio of capital expenditures to total assets. *Crisis* is an indicator variable that is equal to 1 for the 2007:Q3–2008:Q4 period. All regressions include the following additional controls: size (log assets), sales growth, operating income/assets, cash/assets, market-to-book (MTB) ratio, a dummy variable for firms missing MTB ratio that takes the value of 1 when the firm does not report market capitalization, tangible assets/assets, leverage, a dummy variable for firms with market-to-book ratio greater than or equal to 8, cash flow volatility, and a merger and acquisition (M&A) dummy variable that takes the value of 1 when the quarterly growth in total assets is greater or equal to 25 percent. Bank controls are taken from the lead bank and include the total capital ratio, return on assets, core deposit ratio, net charge-off ratio, and missing bank indicator. Instruments are described in the main text. All variables are defined in Appendix A. All independent variables are lagged one period. We include time effects for each and every quarter. Standard errors double-clustered by industry-time and firm in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Next, we split the sample by bond rating and compare non-investment-grade rated firms (including those with no bond rating) to investment-grade rated firms. The estimated effects in the subsample of non-investment-grade rated firms, those most likely to have been severely hit by a drop in aggregate liquidity, shown in columns 5 and 6, are close to the results in the full sample (Table 6, columns 4 and 6). Although the coefficient on the interaction of Drawdown Size and Crisis is significant for investment-grade rated firms in column 8, the sum of the coefficient on Drawdown Size and its interaction with Crisis is not significant. Thus, in addition to representing a small sample, investment-grade firms also exhibit only half of the variation in credit line availability, which reduces significantly the power of the instrument. The results of the bond rating subsample analysis therefore also suggest that financing constraints measured as credit line availability were most relevant for firms that appear more vulnerable to aggregate liquidity shocks.

Our third sample split is by dividend payment status. Table 7, panel B, columns 1–4, shows the results from this split. While we find an effect for firms that pay dividends in the first specification (column 1), we find only marginally significant effects during the crisis (column 2). For firms not paying dividends, generally considered financially constrained, we do not find an effect in the first specification (column 3) and we find a large, positive but insignificant effect during the crisis (column 4). The failure to detect a statistically significant effect is likely driven by a weak first stage (F-statistic is 4.12). As such, we interpret as additional evidence, albeit weak, that our results are driven by the firms for which financing constraints matter most.

The last sample split, shown in Table 7, panel B, columns 5–8, is by firm size. We split the sample by median total assets. For small firms (below the median), we find no effect of credit line drawdown on investment in the first specification (column 5). However, we find a large positive and significant effect during the crisis (column 6) that is in magnitude comparable to the estimate for firms not paying dividends. For large firms (above the median), we find a positive and significant effect in the first specification (column 7) and also during the crisis (column 8).

Taken together, the results for the subsample analysis suggest that firms that were more likely to experience adverse effects

of aggregate liquidity shocks (low-cash-flow, non-investment-grade, and small firms), and therefore had to rely more on their credit facilities during a financial crisis, drew on those facilities to sustain their investment if the funds were available to them.

4.6 Cross-Sectional Evidence—Cash Holdings

So far, we have focused on the predictions of the liquidity insurance hypothesis of credit lines. We now step out of the theoretical framework of Holmström and Tirole (2000) and turn to an alternative reason for the increased use of credit lines during the financial crisis. Anecdotal evidence from the financial crisis suggests that firms drew on their credit lines for precautionary reasons (Ivashina and Scharfstein 2010). As we argued above, the aggregate figures in our sample cast doubt on large (precautionary) cash hoarding associated with the financial crisis. Average cash holdings increased a bit at the onset of the crisis but declined in March 2008 (after the failure of Bear Stearns) and remained relatively constant during the financial crisis. Perhaps surprisingly, cash holdings only increased strongly after mid-2009 (Figure 2). While the average cash holdings could cover up heterogeneity with respect to the firms' overall financial situations, the median cash holdings remained at pre-crisis levels until early 2009 and then increased considerably.

Although the aggregate patterns suggest that precautionary cash hoarding was not the main reason for drawdowns during the crisis, we now formally test for the precautionary cash-hoarding hypothesis, by assessing whether drawdowns during the crisis increase cash holdings. Following Acharya et al. (2014), we use the cash-to-total-assets ratio as a dependent variable in Equation (3) to assess whether firms held in cash the funds drawn in previous periods. Positive coefficients on drawdowns would be consistent with precautionary cash hoarding.

Table 8 shows our estimates of Equation (3) with change in average cash holdings from the pre-crisis to the crisis period as the dependent variable. Perhaps surprisingly, we find a negative relationship between credit line drawdowns during the crisis and the change in cash holdings (column 1). This finding suggests used credit line drawdowns in conjunction with reducing cash holdings to cover capital expenditures. However, as before, the OLS suffers from biases due

Table 8. Cash Holdings: Cross-Sectional Evidence

		Instrumental Variable			
	OLS (1)	**First-Stage Availability (2)**	**Second-Stage Availability (3)**	**First-Stage Committed (4)**	**Second-Stage Committed (5)**
Drawdown Size	−0.103***		0.495		0.349
	(0.039)		(0.301)		(0.325)
Pre-crisis Availability/TA		0.121***			
		(0.032)			
Pre-crisis Committed/TA				0.083***	
				(0.025)	
Firm Controls	Yes	Yes	Yes	Yes	Yes
Industry FEs	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.123		–0.290		–0.135
F-Statistic			14.47		10.86
Number of Obs.	453	451	451	451	451

Note: This table summarizes cross-sectional regression results with change in the average cash-to-asset ratio from pre-crisis (2005:Q4–2007:Q1) to crisis (2007:Q3–2008:Q4) as the dependent variable. All regressions include the following additional controls (pre-crisis averages): cash flow, sales growth, size (measured as the natural log of total assets), market-to-book ratio, leverage, tangible asset ratio, and cash flow volatility. Robust standard errors in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

to some firms not being able to draw on their credit line. Moreover, this negative coefficient does not imply that the cash was used for investment. One alternative purpose would be smoothing dividend payments.

To alleviate the biases in the OLS, we again use pre-crisis credit line availability as an instrument for crisis drawdowns. Column 3 shows that drawdowns had a positive but insignificant effect on cash holdings, suggesting that the OLS specification is indeed biased due to differential access to credit lines during the crisis. We find a similar result when using the committed credit line as an instrument (column 5).

In sum, the cross-sectional evidence suggests that credit line drawdowns during the crisis did not lead to larger cash holdings.

4.7 Panel Evidence—Cash Holdings

We now turn to the panel approach. Table 9 shows our estimates of Equation (5), the panel regression and panel IV regression, with

Table 9. Regression Results: Cash Holdings

	Fixed-Effect Panel Regression		Fixed-Effect Panel IV Regression			
	OLS (1)	**OLS (2)**	**First Stage (3)**	**Second Stage (4)**	**First Stage (5)**	**Second Stage (6)**
Drawdown Size (Lagged)	–0.041	–0.030		–0.504		–0.603
	(0.041)	(0.055)		(0.739)		(1.062)
Drawdown Size * Crisis		–0.029				0.680
		(0.084)				(1.475)
Availability Ratio			0.043***		0.039***	
			(0.006)		(0.006)	
Availability Ratio * Crisis					0.013**	
					(0.006)	
Full Availability			–0.002***		–0.003***	
			(0.001)		(0.001)	
Full Availability * Crisis					0.001	
					(0.001)	
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Time FEs	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.809	0.809		0.149		0.149
F-Statistic				34.869		14.277
Number of Obs.	7,704	7,704	7,704	7,704	7,704	7,704

Note: This table summarizes fixed-effect panel regression results with the cash-to-total assets ratio at time t as the dependent variable. *Crisis* is a dummy variable equal to 1 for the 2007:Q3–2008:Q4 period. Size is measured as the natural log of total assets, and MTB is market-to-book ratio. We include time effects for each and every quarter. We also include a dummy variable for firms that do not report market capitalization (missing MTB) and those with MTB ratio greater than or equal to 8, cash flow volatility, and a merger and acquisition (M&A) dummy variable that takes the value of 1 when the quarterly growth in total assets is greater than or equal to 25 percent. Instruments are described in the main text. Bank controls are taken from the lead bank and include the total capital ratio, return on assets, core deposit ratio, net charge-off ratio, and missing bank indicator. All variables are defined in Appendix A. All independent variables are lagged one period. Standard errors double-clustered by industry-time and firm in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

cash as the dependent variable, in parallel to Table 6.[46] In the fixed-effect panel regression, column 1, we find a small and statistically insignificant point estimate on drawdowns, suggesting that drawdowns, on average, do not increase cash holdings. Consistent with the OLS results in the cross-sectional regression, the coefficient on the interaction of Drawdown Size and Crisis, in column 2, is negative and statistically insignificant, suggesting that cash hoarding did not motivate credit line drawdowns during the financial crisis either.

We then estimate the panel IV regression, again using credit line availability as instrument for drawdowns. The first stage, shown in column 3, is in parallel to Table 6 column 3, except for the omission of the cash-to-total-assets ratio.[47] The omission does not affect the point estimates on the instruments, their significance, or the F-statistic on the first stage.

Our panel IV regression results, shown in column 4, suggest that drawdowns are generally associated with smaller cash holdings, which we interpret as credit line drawdowns working as complement to cash when financing corporate expenditures. The first-stage regression with Crisis interaction terms as additional instruments in column 5 shows similar coefficients as in column 3, suggesting that both instruments—the availability ratio and full availability—and their Crisis interaction terms are strong predictors of drawdowns. Column 6 shows the result of the regression including the interaction term of Drawdown Size and Crisis. The estimated effect is positive but statistically insignificant.[48] In sum, the results in this section provide little support for the cash-hoarding hypothesis.

[46] A positive effect in the panel regression, however, could also indicate lumpiness of drawdown, as firms typically do not draw on their lines every quarter and, as such, drawdowns not spent entirely within a quarter would increase the cash holdings.

[47] However, the point estimate on that ratio was close to zero and insignificant.

[48] This positive coefficient is consistent with Campello, Graham, and Harvey (2010), who report a small but significant effect of precautionary firm policies on credit line drawdowns. However, considering the publicly traded firms in our sample, the effect is statistically insignificant.

4.8 Subsample Analysis—Cash Holdings

As in the case of investment, we conduct a subsample analysis to further explore the cash-hoarding hypothesis.[49] We again split the sample by four proxies for financing constraints during normal market conditions: (i) cash flow (low and high), (ii) bond ratings (investment-grade and non-investment-grade firms), (iii) dividend-paying status, and (iv) size (small and large firms).

Table 10, panel A, columns 1–4, shows the results for the low- and high-cash-flow sample split. As in Section 3.2, we define firms with above the median drop in operating margin between pre-crisis and crisis as low-cash-flow firms, and those with below the median drop in operating margin as high-cash-flow firms. The IV regression results for the subsample of low-cash-flow firms (columns 1 and 2) exhibit similar patterns as the results in the full sample (Table 9, columns 4 and 6). The first specification results in a negative, albeit statistically insignificant, effect. The interaction term (column 2) is positive but insignificant. We also find no significant effects for the subsample of high-cash-flow firms (columns 3 and 4).

Next, we split the sample by bond rating and compare non-investment-grade rated firms (including those with no bond rating) to investment-grade rated firms. The estimated effects for non-investment-grade rated firms (columns 5 and 6) are close to the results in the full sample (Table 9, columns 4 and 6), but, as in the case of investment, we find no effects for investment-grade rated firms.[50] In fact, the point estimates show the opposite sign compared with the full sample results.

Our third and fourth sample splits are by dividend payment status and by firm size, respectively. Table 10, panel B shows the results. The point estimate on the interaction term is negative and insignificant in the dividend-payer subsample. More generally, we find positive but statistically insignificant effects of credit line drawdowns during the financial crisis on cash holdings in these subsamples.

[49] In unreported results, using alternative macrovariables to control for aggregate liquidity shocks such as the TED spread or the tightening of lending standards in SLOOS, we do not find evidence for amplification of the effect of drawdowns on cash holdings during the crisis (the interactions of Drawdown Size and the TED spread or SLOOS are positive but insignificant).

[50] Again, for this small subsample, credit line availability is a weak instrument.

Table 10. Cash Holdings—Subsample Analysis

	Panel A							
	Cash Flow				Bond Rating			
	Low		High		Non-investment		Investment	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drawdown Size	–0.441	–0.908	–0.587	0.297	–0.642	–0.867	0.697	2.286
(Lagged)	(1.262)	(1.698)	(0.514)	(1.288)	(0.779)	(1.131)	(0.841)	(1.784)
Drawdown Size *		1.790		–2.133		1.033		–3.723
Crisis		(1.806)		(3.343)		(1.586)		(2.852)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Time FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.125	0.098	0.154	0.107	0.151	0.146	0.052	–0.282
F-Statistic	17.474	7.309	26.692	4.707	33.268	13.244	8.663	2.192
Number of Obs.	3,816	3,816	3,831	3,831	6,699	6,699	889	889
	Panel B							
	Dividend Payer				Size			
	Yes		No		Small		Large	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Drawdown Size	0.106	0.211	–1.656	–2.150	–0.623	–0.286	0.005	–0.151
(Lagged)	(0.474)	(0.752)	(1.462)	(2.125)	(1.216)	(1.712)	(0.381)	(0.520)
Drawdown Size *		–0.072		1.962		1.251		0.398
Crisis		(1.361)		(3.107)		(2.587)		(0.936)
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Time FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.096	0.093	0.135	0.121	0.188	0.185	0.115	0.111
F-Statistic	31.369	12.120	16.239	4.134	26.633	9.996	20.502	10.009
Number of Obs.	4,141	4,141	3,537	3,537	3,708	3,708	3,946	3,946

Note: This table summarizes fixed-effect panel regression results with the cash-to-total-assets ratio at time t as the dependent variable. *Crisis* is a dummy variable that is equal to 1 for the 2007:Q3–2008:Q4 period. Size is measured as the natural log of total assets, and MTB is market-to-book ratio. We include time effects for each and every quarter. We also include a dummy variable for firms that do not report market capitalization (missing MTB), and those with MTB ratio greater than or equal to 8, cash flow volatility, and a merger and acquisition (M&A) dummy variable that takes the value of 1 when the quarterly growth in total assets is greater than or equal to 25 percent. Bank controls are taken from the lead bank and include the total capital ratio, return on assets, core deposit ratio, net charge-off ratio, and missing bank indicator. Instruments are described in the main text. All variables are defined in Appendix A. All independent variables are lagged one period. Standard errors double-clustered by industry-time and firm in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Taken together, the results for the subsample analysis do not provide evidence for the presence of cash-hoarding motives for drawdowns during the crisis. The point estimates for constrained firms are positive, insignificant at conventional levels, and small in economic magnitude. These results may be suggestive of a precautionary motive for financially constrained and bank-dependent firms. However, the results are weak and small, and we cannot rule out that the positive effects are driven by the lumpiness of drawdowns.

5. Discussion of Results

This section puts together our results in testing both the real effect and the cash-hoarding hypotheses. Overall, our findings on the real effect hypothesis indicate that firms use credit line drawdowns to maintain their investment spending after adverse idiosyncratic shocks to their revenue and cash flows. When addressing the potential endogeneity of drawdowns by conditioning on access to credit lines—credit line availability—we find positive and significant real effect of drawdowns (about 12 percent increase in average capital expenditures). This effect is substantially amplified during the financial crisis (to about 45 percent on average). In other words, firms with more availability were able to use their credit lines to sustain their investment spending during times of low aggregate liquidity. In comparison with the findings in the literature on financing constraints, our estimates are conditional on firms having credit lines but facing restricted access to them, rather than firms being constrained and unable to secure a credit line. Covenant-induced restrictions on the use of credit lines therefore imply smaller investment spending financed by drawdowns. Thus, the magnitude of our estimated effect is comparable to the 13 percent decline in investment after debt covenant violations of Chava and Roberts (2008). Our findings are then consistent with the view that financing constraints affect investment by restricting the access to credit line use (Sufi 2009; and Huang 2010).

Our results using different subsamples confirm that the real effects of credit line drawdowns on investment seem robust to different proxies for aggregate shocks during the crisis, different subsamples of firms to account for the role of financing constraints, and

to some extent different ways to measure investment. All robustness checks confirm the large effects of drawdowns on investment and the considerable amplification of this effect during the crisis, particularly for smaller and more financially constrained firms. These findings emphasize the importance of financing constraints and are consistent with Duchin, Ozbas, and Sensoy (2010), who find larger declines in investment for firms that are financially constrained. Unlike these authors who measure financing constraints as low cash reserves or high net short-term debt, in this paper we focus on size, dividend-paying status, and bond ratings. Our panel evidence complements Campello, Graham, and Harvey (2010) and Campello et al. (2011), who use a survey of CFOs and find that financially constrained firms relied on credit lines for cash and cut investment when credit was not available during the financial crisis.

On the cash-hoarding hypothesis, we do not find evidence that credit line drawdowns led to cash hoarding during the crisis. Our results suggest that on average, smaller and more financially constrained firms were already "burning their cash" at times when they drew on their credit lines. Since lumpiness of drawdowns tends to bias the regressions in the direction of finding an effect on cash holdings, the absence of an effect is strong suggestive evidence that precautionary motives were not the main driver of drawdowns. Our graphic evidence suggests possible precautionary motives after the failure of Lehman Brothers, consistent with the anecdotal evidence in Ivashina and Scharfstein (2010). This one-quarter effect is, however, hard to detect in the data.

From a policy perspective, it is important to note that our results are based on a sample of relatively large and publicly traded firms. Financially stressed banks are typically reluctant to cut credit to these firms because such cuts, and thereby the financial stress of the banks, would be publicly disclosed in regulatory filings. It is, however, plausible that the precautionary motive or bank health were significant concerns for small- and medium-sized enterprises as suggested by Ippolito et al. (2016). As such, policies exclusively targeting banks during times of financial stress may not be sufficient to maintain investment of small firms. Other programs targeting small firms directly, such as the Paycheck Protection Program during the COVID-19 pandemic, may be more successful in alleviating financial strains of smaller firms.

6. Conclusion

Using a unique data set, we document that credit line drawdowns had already increased in 2007, when disruptions in bank funding markets began to squeeze aggregate liquidity. This finding suggests that banks continued to provide liquidity to firms during the financial crisis. However, this realization of banks' off-balance-sheet risk put additional pressure on banks, even though debt covenants can reduce firms' access to credit lines.

We exploit this variation in access to credit lines across firms as an institutional characteristic of credit line contracts to instrument for the size of the drawdowns. Our key finding is that there are real effects associated with the use of credit lines. We show that firms use their drawdowns to finance investment, thereby providing empirical evidence that credit lines work as liquidity insurance that allows corporations to keep up with their investment plans during times of financial stress. This situation seems to be particularly relevant in an environment in which other funding sources, such as market debt, are not available. The effects of credit line drawdowns on investment are economically large and statistically significant. A one-standard-deviation increase in the size of the drawdown is associated with a 12 percent increase in average capital expenditures (an increase of 0.2 percent of total assets). The financial crisis amplified the effect of drawdowns on investment significantly. The effect of drawdowns on investment increases to 45 percent in the full sample—especially for smaller and financially constrained firms. We find only weak evidence that financially constrained firms drew on their lines to boost (precautionary) cash holdings during the crisis, which seems consistent with our findings that the drawdowns during the financial crisis did not necessarily reflect concerns about the health of their lenders.

Appendix A. Data Definitions and Sources

Firm Variables

Capital Expenditures (Capex): Cash outflows used for additions to firm's property, plant, and equipment. Source: Compustat.

Cash: Sum of all cash and cash-like instruments. Source: Compustat.

Cash Flow: Proxied by operating margin, defined as income less all operating expenses. Source: Compustat.

Cash Flow Volatility: Standard deviation of quarterly cash flows over the previous 16 quarters. Source: Compustat.

Credit Line Availability: Amount of credit line that can be accessed. Note that availability can be lower than the total credit line because of letters of credit and other covenant restrictions. Source: SEC filings.

Credit Line Availability Ratio: Credit line availability divided by total assets. Source: SEC filings.

Full Availability Dummy: A dummy equal to 1 if a firm has a credit line availability ratio of 100 percent. Source: SEC filings.

Committed Amount: Total credit line commitment, which includes the total revolving credit line (used and undrawn amounts) and term loans. Source: SEC filings.

Credit Line Use: The quarterly outstanding amount of the revolving credit line. Source: SEC filings.

Credit Line Drawdown Size: The quarterly difference in the outstanding amount on the credit line divided by total assets. Source: SEC filings.

Credit Line Drawdown Dummy: A dummy equal to 1 if the quarterly difference in the outstanding amount on the credit line is positive, and 0 otherwise. Source: SEC filings.

Leverage: The sum of long-term debt and debt in current liabilities divided by total assets. Source: Compustat.

Market-to-Book Ratio: The sum of market value of equity and book value of debt divided by total assets. Source: Compustat.

PPE: Sum of property, plant, and equipment plus depreciation. Source: Compustat.

Sales Growth: The quarterly growth in sales. Source: Compustat.

Tangible Assets: Total assets less intangible assets. Source: Compustat.

Total Assets: Sum of firm assets. Source: Compustat.

M&A Dummy: Merger and acquisition dummy that takes the value of 1 when the quarterly growth in total assets is greater than or equal to 25 percent. Source: Compustat.

Lead Bank Variables

Tier 1 Capital/RWA: Ratio of a bank's regulatory capital (tier 1 capital) to its risk-weighted assets. Source: FR Y-9C and Call Reports.

Share of Core Deposits: Ratio of a bank's core deposits (transaction, savings, and small time deposits) to its total assets. Source: FR Y-9C and Call Reports.

Net Charge-offs/TA: A measure of bank loan quality, the ratio of net charge-offs (loan charge-offs minus recoveries) over total assets. Source: FR Y-9C and Call Reports.

ROA: Ratio of a bank's net income to its average assets. Source: FR Y-9C and Call Reports.

Missing Lead Bank: A dummy equal to 1 if the firm does not provide information on its lead bank.

Macrovariables

SLOOS: The net percentage of senior loan officers that report a tightening of lending standards in the Federal Reserve's Senior Loan Officer Opinion Survey. Source: Federal Reserve.

TED Spread: Difference between the three-month London interbank offered rate and the three-month U.S. Treasury rate. Source: Federal Reserve Economic Data (FRED).

Appendix B. Credit Line Data Taken from SEC Regulatory Filings

1. Bernard Chaus Inc., from 10-K and 10-Q filings in June and September 2006:

"The company has a financing agreement with CIT Group which provides a $50.5 million facility comprised of (i) a $40 million revolving line of credit with a $25 million sublimit for letters of credit, and (ii) a $10.5 million term loan. The term loan is paid down in quarterly installments of $425,000 with a balloon payment of $1.8 million due on October 1, 2008. The Financing Agreement contains numerous financial and operational covenants, including limitations on additional indebtedness, liens, dividends, stock repurchases and capital expenditures. In addition, the Company is required to maintain (i) specified levels of tangible net worth, (ii) minimum EBITDA, (iii) certain fixed charge coverage ratios, (iv) certain leverage ratios,

and (v) specified levels of minimum borrowing availability under the Revolving Facility. At June 30, 2006, the Company had $5.1 million of outstanding letters of credit, total availability of approximately $16.6 million, a balance of $5.6 million on the term loan and $2.4 million on the revolving credit borrowings. On September 30, 2006, the company had $3.7 million of outstanding letters of credit under the Revolving Facility, total availability of approximately $20.2 million, a balance of $5.2 million on the term loan and $6.0 million in revolving credit borrowing."

Based on this information, we collect the variables in US$ million (shown together with total assets from Compustat), shown in Table B.1.

Table B.1. Variables: Bernard Chaus Inc.

	Revolving	**Used**	**Unused**	**Available**	**Total Assets**
2006:Q2	40.0	2.4	37.6	16.6	39.9
2006:Q3	40.0	6.0	34.0	20.2	45.9

From this table, we construct the following variables as of 2006:Q3:

Drawdown = $Used_t - Used_{t-1}$= $3.6 million

Drawdown Size = Drawdown/Total Assets = 0.09

Credit Line Availability = $20.2 million

Availability Ratio = Available/Total Assets = 0.44

2. Gibraltar Industries Inc., from 10-Q lings in March and June 2007:

"The Company's credit agreement provides a revolving credit facility, which expires in December 2010, and a term loan, which is due in December 2012. The revolving credit facility of up to $300.0 million and the term loan of $230.0 million are secured with the Company's accounts receivable, inventories and personal property and equipment. At March 31, 2007, the Company had used approximately $94.9 million of the revolving credit facility and had letters of credit outstanding of $17.3 million, resulting in $187.8 million in availability. Borrowings under the revolving credit facility

carry interest at LIBOR plus a fixed rate. At March 31, 2007, the term loan balance was $123.3 million. At June 30, 2007, the Company had used approximately $127.1 million of the revolving credit facility and had letters of credit outstanding of $21.2 million, resulting in $151.7 million in availability. At June 30, 2007, the term loan balance was $122.7 million."

Based on this information, we collect the following variables in US$ million (shown together with total assets from Compustat), shown in Table B.2:

Table B.2. Variables: Gibraltar Industries Inc.

	Revolving	Used	Unused	Credit Letters	Available	Total Assets
2007:Q1	300.0	94.9	205.1	17.3	187.8	1,198.0
2007:Q2	300.0	127.1	172.9	21.2	151.7	1,256.4

From this table, we construct the following variables as of 2007:Q2:

Drawdown $= Used_t - Used_{t-1} =$ $32.2 million
Drawdown Size $= Drawdown/Total\ Assets_{t-1} = 0.03$
Credit Line Availability = $151.7 million
Availability Ratio = Available/Total Assets = 0.12

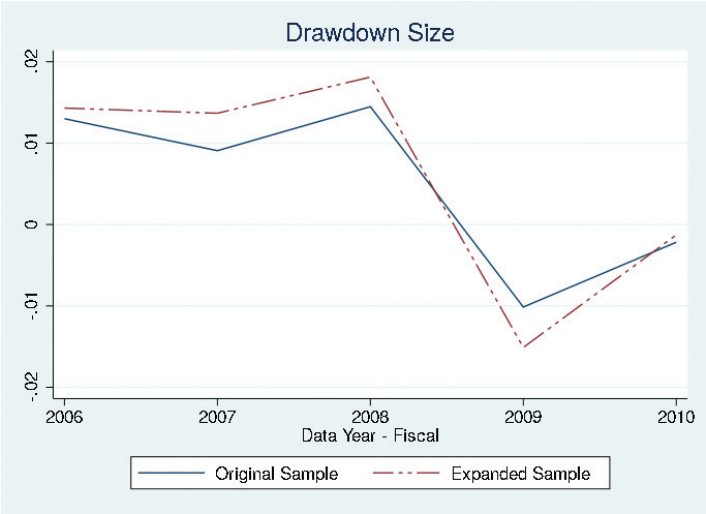
Appendix C. Sample Validation

This appendix provides support to validate our sampling assumptions. We first compare credit line drawdowns in our sample with a larger sample from Capital IQ on an annual basis. We then compare our sample with the full Compustat sample.

Comparison with Capital IQ Drawdown Data

Our hand-collected, quarterly credit line data for the financial crisis period have considerable quality advantages over Capital IQ credit line data, which are unreliable at a quarterly frequency. Specifically, Mathers and Giacomini (2016) show that Capital IQ total credit line

Figure C.1. Credit Lines Drawdown Comparison



Note: This chart compares outstanding credit line balances for our sample of 470 firms with an extended sample from Capital IQ at the annual frequency.

data is consistent with regulatory filings in only 68 percent of the cases. For used and unused credit line amounts (and therefore for drawdowns), only 23 percent of the Capital IQ reported numbers were consistent with regulatory filings. The annual data are somewhat better and hence we follow Acharya et al. (2014) and compare our sample with Capital IQ at the annual frequency. We compare estimates of the impact of Cash Flow/TA on drawdowns during the crisis using the annual data in our sample and in the extended Capital IQ sample (3,500 firms).

Figure C.1 shows that the annual drawdown pattern in our sample and in the Capital IQ data are similar. This comparison already suggests that the credit line drawdowns in our sample are representative and comparable with what has been documented in other studies using annual data.

Table C.1 shows the results of repeating the drawdown regressions for our sample (columns 1 and 2) and for the extended sample (columns 3 and 4). Consistent with our results shown in Table 3, panel A, which uses quarterly data, the coefficients on both Cash

Table C.1. Drawdown Size Regression: Comparison

	Annual Data			
	Hand-Collected		Capital IQ	
	(1)	(2)	(3)	(4)
Cash Flow/TA	–0.035	0.063*	0.011	0.015*
	(0.025)	(0.027)	(0.008)	(0.008)
Cash Flow/TA * Crisis		–0.054*		–0.016*
		(0.029)		(0.008)
Firm Controls	Yes	Yes	Yes	Yes
Industry-Time FEs	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes
Adjusted R^2	0.01	0.01	0.03	0.03
Number of Obs.	2,105	2,105	11,934	11,935

Note: This table summarizes fixed-effect panel regression results with drawdown size at time t as the dependent variable. Additional firm controls are size (log of total assets), cash/assets, tangible assets/assets, and leverage. All variables are defined in Appendix A. All independent variables are lagged one period. We include industry-time and firm fixed effects. Robust standard errors are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Flow/TA and its interaction with Crisis (equal to 1 for the years 2007 and 2008) have the expected signs and are significant in both our sample and the extended sample. The smaller coefficients in the Capital IQ sample compared with similar coefficient in our sample is likely to reflect attenuation bias due to incorrect and missing data. Understandably, the results look statistically and economically weaker in the annual data (the quarterly regression implies an effect more than twice as large), as most of the variation in our variables of interest occur at a quarterly frequency, and between 2007:Q2 and 2009:Q2, with the peak in the series occurring in 2008:Q3 and 2009:Q1. The results suggest that the hand-collected data, albeit for a smaller sample, have significant advantages to the Capital IQ data for the purpose of this study.

Comparison with Full Compustat Sample

The 470 firms in our sample are representative of the universe of firms in Compustat by industry classification (Table C.2),

credit-rating classification (Table C.3), and firm size (Figure C.2).

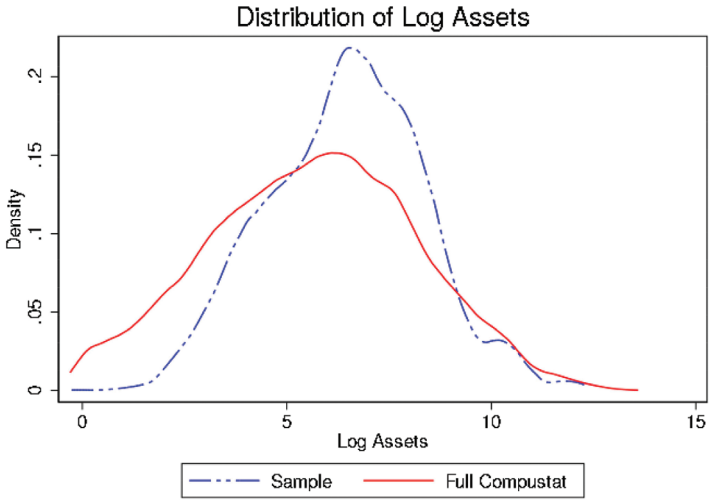
Table C.2. Industry Classification

Industry	Sample	Full Compustat
Agriculture	0.000	0.006
Mining	0.064	0.147
Utilities	0.000	0.000
Construction	0.007	0.013
Manufacturing	0.522	0.432
Wholesale Trade	0.046	0.032
Retail Trade	0.051	0.042
Transportation	0.048	0.031
Information	0.108	0.138
Finance	0.002	0.000
Real Estate	0.009	0.006
Technical Services	0.034	0.053
Support and Waste Management	0.021	0.018
Education	0.005	0.005
Healthcare	0.041	0.019
Arts and Entertainment	0.009	0.008
Accommodations and Hospitality	0.021	0.019
Other	0.011	0.031

Table C.3. Credit-Rating Classification

Credit Rating	Sample	Full Compustat
Investment Grade	0.132	0.119
High Yield or No Rating	0.868	0.881

Figure C.2. Firm Size



Appendix D. Robustness

This appendix shows regressions results documenting the robustness of the difference-in-difference regressions to different timing and of the capital expenditure regression to other measures of crisis as well as the effect of covenant breaches on two outcomes: (i) credit line availability and (ii) credit line drawdowns.

Drawdown Difference-in-Difference Approach—Robustness

In this subsection we provide additional tests for the difference-in-difference approach regressing drawdowns on low cash flow. In Section 3.4, we define a dummy variable (after) that is equal to 1 from 2007:Q3 on, including the post-crisis period. In Table D.1, we replace after with dummy variable crisis, which is equal to 1 between 2007:Q3 and 2008:Q4, and show the results in parallel to Table 2 but dropping the post-crisis period. We find that our results are robust to dropping the post-crisis observations.

Table D.1. Difference-in-Difference Regression Results: Credit Line Use

	OLS Regression		Fixed-Effect Regression	
	(1)	(2)	(3)	(4)
Low Cash Flow	0.006	0.009		
	(0.007)	(0.007)		
Low Cash Flow * Crisis	0.010*	0.011**	0.010***	0.009***
	(0.005)	(0.005)	(0.002)	(0.002)
Size		–0.010***		0.010**
		(0.002)		(0.004)
Cash/TA		–0.122***		–0.055***
		(0.017)		(0.010)
Leverage		0.109***		0.096***
		(0.023)		(0.012)
Market-to-Book Ratio		–0.002		–0.002**
		(0.003)		(0.001)
Missing MTB		–0.063***		–0.041***
		(0.015)		(0.017)
Bank Controls	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	No	No	Yes	Yes
Adjusted R^2	0.009	0.181	0.793	0.802
Number of Obs.	4,587	4,587	4,584	4,584

Note: This table summarizes difference-in-difference regression results with credit line use as the dependent variable for the sample period 2005:Q4–2008:Q4. Credit line use is scaled by total assets. Low cash flow is an indicator variable equal to 1 if the firm faces a large drop in its operating margin. A large drop is defined as below the median change in operating margin from before to after the crisis. *Crisis* is an indicator variable equal to 1 from 2007:Q3 and 2008:Q4. All variables are defined in Appendix A. All independent variables are lagged one period. Standard errors double-clustered by industry-time and firm in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Investment—Robustness

In this subsection we provide additional tests for the relationship between drawdowns and investment. First, we consider two additional crisis measures: the TED (LIBOR-Treasury) spread and the tightening of lending standards from the Senior Loan Officer Opinion Survey (SLOOS). The TED spread is commonly used as a measure of liquidity stress in bank funding markets. The SLOOS directly measures changes in the credit supply by banks.

Table D.2. Capital Expenditure Regressions: Robustness

	Fixed-Effect Panel IV Regressions			
	Macrovariables		Investment in PPE	
	(1)	(2)	(3)	(4)
Drawdown Size	–0.260	–0.054	0.183**	0.063
	(0.177)	(0.071)	(0.093)	(0.129)
Drawdown * TED	0.005**			
	(0.002)			
Drawdown * SLOOS		0.007***		
		(0.002)		
Drawdown * Crisis				0.319
				(0.239)
Bank Controls	Yes	Yes	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes
Time Effects	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes
Adjusted R^2	–0.268	–0.221	–0.059	–0.081
F-Statistic	3.380	18.158	56.677	21.674
Number of Obs.	7,704	7,704	7,704	7,704

Note: This table summarizes fixed-effect panel regression results with capital expenditure at time t as the dependent variable. Capital expenditure is measured as the ratio of capital expenditures to total assets. In columns 3 and 4 investment is measured as the ratio of the change in PPE to total assets. *Crisis* is an indicator variable that is equal to 1 for the 2007:Q3–2008:Q4 period. The TED spread is defined as LIBOR minus the Treasury rate of similar maturity. SLOOS, measuring banks' willingness to lend, is taken from the Federal Reserve's Senior Loan Officer Opinion Survey. All variables, including firm and bank controls, are defined in Appendix A. All independent variables are lagged one period. Standard errors double-clustered by industry-time and firm in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

Table D.2, columns 1 and 2, shows the results of these robustness regressions. We find that both alternative measures for low aggregate liquidity yield results comparable to the main specification.

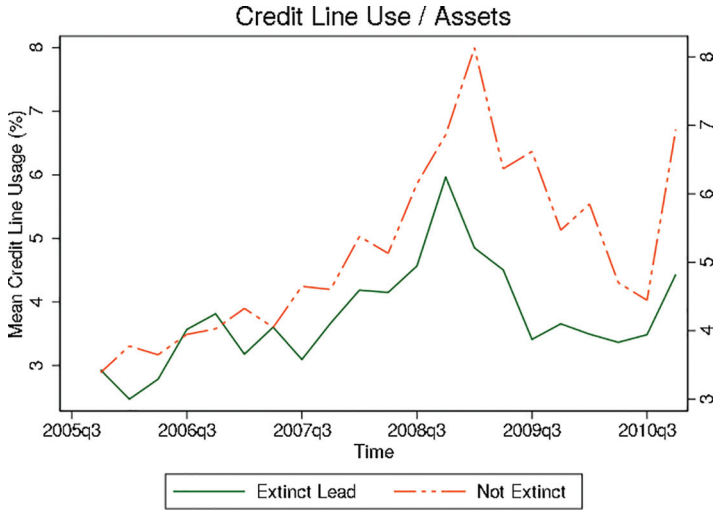
Next, we consider a different measure for investment: changes in property, plant, and equipment. Table D.2, columns 3 and 4, shows the results for these robustness regression with changes in property, plant, and equipment (PPE) as the dependent variable. Column 3 shows a positive and statistically significant effect of drawdowns on investment. When adding the Crisis interaction term in column 4, we find a positive, albeit statistically insignificant, effect of credit

line drawdowns on changes in PPE during the financial crisis. Thus, while the PPE result appears to confirm the economic importance, it is measured with considerable uncertainty.

Did Bank Health Matter?

We assess whether firms' drawdowns were influenced by their lead bank's financial health during the financial crisis. The first piece of evidence comes from a comparison of the drawdown behavior of firms that had relationships with lead banks that disappeared, either due to bankruptcy, mergers, or acquisitions, during the financial crisis. Figure D.1 shows that there are no noticeable differences in drawdowns between firms borrowing from extinct lead banks and other firms in our sample.

Figure D.1. Drawdowns and Bank Health



Note: Extinct lead banks are banks that either went bankrupt or lost independence due to a merge during the financial crisis.

The second piece of evidence comes from additional regressions. Beyond including bank controls, we expand our panel regression equation for Drawdown Size with triple interactions of Crisis, the liquidity shock measures (Cash Flow/TA and Sales Growth), and

two dummy variables that proxy for the lead banks' financial health: an indicator that is equal to 1 if the banks capital ratio is above the sample median (High Bank Capital), and another indicator that is equal to 1 if the bank's short-term wholesale funding (STWF) ratio is below the sample median (Low STWF). If firms drew more from weaker banks (e.g., low bank capital and high STWF ratio) during the financial crisis, then the coefficient on the triple interactions should be positive and significant.

In Table D.3, the coefficients on the triple interactions of Sales Growth, Crisis, and High Capital and Sales Growth, Crisis, and Low STWF in columns 5 and 6, respectively, are positive but not significant at conventional levels. The coefficients on the triple interactions of Cash Flow/TA, Crisis, and High Capital and Cash Flow/TA, Crisis, and Low STWF in columns 2 and 3, respectively, are negative and again insignificant at conventional levels. These results suggest that in the face of the liquidity shock brought by the financial crisis, firms did not draw on their credit lines differentially more from weaker banks, and thus we conclude that the drawdowns observed during the financial crisis for the firms in our sample did not necessarily reflect concerns about the health of their lenders.[51] Our results suggest that drawdowns during the financial crisis did not necessarily reflect concerns about the health of the banks.

There are several potential explanations for this apparently surprising result. First, in contrast to Ippolito et al. (2016), who use an Italian credit register, we focus on large, publicly traded firms borrowing in syndicated loan markets and therefore able to substitute their borrowing from weak to strong banks within the syndicate. These results reinforce our interpretation that for publicly traded firms in the United States, differences in bank health were not the main determinant of drawdowns and, by extension, of the use of funds. To be clear, we agree with Ivashina and Scharfstein (2010) that the deterioration of bank health after the collapse of Lehman Brothers led to drawdowns out of concern about the stability of the whole banking system, but there is little evidence in our data that publicly traded firms discriminated by bank health. Further, since

[51] In unreported results, we also find that firms did not draw down differentially more from healthy banks for investment or differentially less from weak banks for cash-hoarding purposes.

Table D.3. Regression Results: Drawdown Size and Bank Health

	(1)	(2)	(3)	(4)	(5)	(6)
Cash Flow/TA	–0.015	–0.013	–0.017			
	(0.012)	(0.010)	(0.016)			
Cash Flow/TA * Crisis	–0.025***	–0.015	–0.017*			
	(0.010)	(0.011)	(0.009)			
Cash Flow/TA * Crisis * High Capital		–0.037				
		(0.028)				
Cash Flow/TA * Crisis * Low STWF			–0.024			
			(0.026)			
Sales Growth				–0.002*	–0.002	–0.001
				(0.001)	(0.002)	(0.002)
Sales Growth * Crisis				–0.004**	–0.005**	–0.005**
				(0.002)	(0.002)	(0.002)
Sales Growth * Crisis * High Capital					0.005	
					(0.004)	
Sales Growth * Crisis * Low STWF						0.003
						(0.003)
Lower Interactions	No	Yes	Yes	No	Yes	Yes
Firm Controls	Yes	Yes	Yes	Yes	Yes	Yes
Bank Controls	Yes	Yes	Yes	Yes	Yes	Yes
Industry-Time FEs	Yes	Yes	Yes	Yes	Yes	Yes
Firm FEs	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.058	0.058	0.058	0.060	0.060	0.059
Number of Obs.	7,704	7,704	7,704	7,704	7,704	7,704

Note: This table summarizes fixed-effect panel regression results with drawdown size at time t as the dependent variable. Sales growth is measured as the quarterly change in sales divided by previous-quarter sales. *Crisis* is a dummy variable equal to 1 for the 2007:Q3–2008:Q4 period. Additional firm controls are size (log of total assets), cash/assets, market-to-book (MTB) ratio, a dummy variable for firms missing MTB ratio that takes the value of 1 when the firm does not report market capitalization, tangible assets/assets, leverage, used credit line/available credit line as a measure of remaining debt capacity, a dummy variable for firms with market-to-book ratio greater than or equal to 8, cash flow volatility, and a merger and acquisition (M&A) dummy variable that takes the value of 1 when the quarterly growth in total assets is greater than or equal to 25 percent. Bank controls are taken from the lead bank and include the total capital ratio, return on assets, core deposit ratio, net charge-off ratio, and missing bank indicator. High capital is an indicator that is equal to 1 if the lead banks' capital ratio is above the sample median. All variables are defined in Appendix A. All independent variables are lagged one period. We include industry-time and firm fixed effects. Robust standard errors are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

we define the crisis as 2007:Q3–2008:Q4, the impact of the failure of Lehman Brothers, highlighted in Ivashina and Scharfstein (2010), is muted in our sample. Second, the Troubled Assets Relief Program (TARP) that helped stabilize the banking system came into effect in 2008:Q4, immediately alleviating financial concerns about the U.S. banking system.

Consistent with the effects of TARP, Figure 3 shows that firms began to repay their credit lines in early 2009. Third, although we match firms with their lead banks, we do not have information about the credit lines and the share of lending they obtain from the banks and thus we do not fully account for bank-firm matching.

Covenant Breaches

Finally, to estimate the effect of covenant breaches, we run the following regression:

$$Outcome_{i,t} = c_i + \tau_t + \beta_1 \; Covenant \; Breach_{i,t-1} + \gamma \cdot X_{i,t-1} + \epsilon_{i,t}. \tag{D.1}$$

Table D.4 shows the results of estimating Equation (D.1). The first two columns show that after a covenant breach, measured as an indicator variable that is equal to 1 in quarters of covenant violations, credit line availability drops by about 5 percent in the next quarter. The effect is somewhat muted during the crisis, but this effect is imprecisely estimated. These responses of credit line availability to covenant breaches show that, while important, covenant breaches do not fully restrict a firms access to credit.

The third and fourth columns of Table D.4 show the results for credit line drawdown size. While the estimated coefficient exhibits expected negative sign, it is statistically insignificant. One explanation for this finding is that the indicator variable used to measure covenant breaches is likely to be too coarse to accurately estimate the effect of covenant breaches, as the intensity of treatment may differ across firms. Together with the response of credit line availability to covenant breaches documented in the first three columns, the results show that differences in intensity of treatment are better measured with credit line availability, which provides a continuous measure of financing constraints.

Table D.4. The Effect of Covenant Breaches

	Credit Line Availability			Drawdown Size		
	(1)	(2)	(3)	(4)	(5)	(6)
Covenant Breach	–0.061***	–0.071***	–0.068***	–0.000	–0.001	–0.000
	(0.016)	(0.020)	(0.020)	(0.001)	(0.002)	(0.002)
Covenant Breach * Crisis		0.028	0.025		0.002	0.002
		(0.031)	(0.031)		(0.003)	(0.003)
Cash/TA			0.050*			0.005*
			(0.030)			(0.003)
Size			–0.001			–0.000
			(0.007)			(0.001)
Tangible Assets/TA			–0.050*			–0.006*
			(0.029)			(0.003)
Market-to-Book Ratio			0.001			–0.000
			(0.005)			(0.000)
MTB over 8 Dummy			0.036			0.004
			(0.025)			(0.003)
Indicator for Missing MTB			0.045			0.002
			(0.030)			(0.004)
Available			0.106***			0.035***
			(0.032)			(0.004)
Leverage			0.012			–0.014***
			(0.018)			(0.002)
Cash Flow Volatility			–0.618***			–0.038*
			(0.136)			(0.020)
MA Dummy			–0.001			0.007***
			(0.011)			(0.002)
Time Effects	Yes	Yes	Yes	Yes	Yes	Yes
Firm Fixed Effects	Yes	Yes	Yes	Yes	Yes	Yes
Adjusted R^2	0.553	0.553	0.555	0.009	0.009	0.048
Number of Obs.	7,739	7,739	7,739	7,739	7,739	7,739

Note: This table summarizes fixed-effect panel regression results with credit line availability and drawdown size at time t as the dependent variable. Credit line availability is the fraction of the credit line that can be accessed divided by the credit line limit. Drawdown size is dollar amount drawn divided by total assets. *Covenant Breach* is an indicator variable that is equal to 1 in the quarter in which a firm violates a covenant. Firm controls include the following additional controls: size (log assets), sales growth, operating income/assets, cash/assets, market-to-book (MTB) ratio, a dummy variable for firms missing MTB ratio that takes the value of 1 when the firm does not report market capitalization, tangible assets/assets, leverage, a dummy variable for firms with market-to-book ratio greater than or equal to 8, cash flow volatility, and a merger and acquisition (M&A) dummy variable that takes the value of 1 when the quarterly growth in total assets is greater than or equal to 25 percent. Robust standard errors are in parentheses. $^{*}p < 0.10$, $^{**}p < 0.05$, $^{***}p < 0.01$.

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