Balance Rights and Responsibilities in Liquidity Supply and Demand Contracts

John C. Chu* Zhanbing Xiao†

This revision: November 2023

Latest Version

Abstract

We propose three assumptions to model a fair liquidity contract between demand and supply. The first two assumptions are active banks and uncertain corporate revenues. In Assumption Three, we allow either side to maximize its long-term assets. Active banks decline requests if the income-generating capacity of borrowers is of concern. Due to uncertain revenues, some entrepreneurs are exposed to unexpected liquidity shortages when operating their routine business. We model convergent decisions from the liquidity supply and demand sides through extensive-form games. Our model can explain two stylized facts. Why do some, but not all, companies have access to credit lines? Why does a company have access to term loans or convertible debt instead? Our empirical analysis focuses on two credit line questions. How do we explain the distribution of credit line contracts? Companies with sufficient internal liquidity do not apply for credit line access. Banks unconditionally deny liquidity demand from companies that are small or generate low operating income or volatile cash flows. We also document conditional contract approvals. Credit lines substitute for cash holdings or cash flows. The second question satisfies the identification hurdle. We document the demand-side explanations for drawdowns of regular borrowers with credit line contracts in 2008 and 2009? By contract obligations, borrowers decide their drawdown amounts, and banks must honor drawdown requests. We present quantitative and qualitative evidence from 10-K to support the demand side story. The regression results confirm that fractional drawdowns are sufficient to neutralize the internal liquidity shortages of regular borrowers.

Keywords: Fair rights and responsibilities, liquidity supply and demand, active banks, uncertain operating income, demand side story.

*Corresponding author, Monash Business School, Monash University. Email: john.chu@monash.edu. Tel: +61-3-9903-4546.

†The Salata Institute for Climate and Sustainability, Harvard University. Email:zhanbingxiao@fas.harvard.edu.

JEL Codes: G21, G30.

1 Introduction

Much of the literature on modern corporate liquidity management is built on the theoretical foundation of Holmström and Tirole (1998). Over two decades, researchers have identified the roles of cash flows, cash holdings, term loans, and credit lines to finance investment projects in the corporate finance literature. Refer to Almeida et al. (2004) for a literature survey.

We propose three assumptions to model contracts of external liquidity. On the liquidity demand side, we assume uncertain (or stochastic) corporate revenues. On the supply side, we assume active liquidity suppliers. Both assumptions are not in Holmström and Tirole (1998). Stochastic corporate revenues refer to time-varying operating income, which can be negative due to the nature of risk taking. An active bank will reject bank loan demands if the poor track record of the loan applicant is unlikely to meet debt payment obligations. To ensure an ex-ante *fair* contract, we must allow banks, just as any entrepreneur, to prioritize their own interests, maximizing assets in the long term. This is the third assumption. Why is the combination of three assumptions necessary?

Here is the short answer. There exists a delay in the exchange of rights and responsibilities between liquidity demand and supply. Upon a loan drawdown at $t = 0$, the bank has fulfilled its responsibility and the entrepreneur has exercised its rights. However, the return of entrepreneurs' responsibilities and bank's rights is not completed by the end of N^{th} year, during which there is uncertainty due to limited commitment of the borrowers.

The borrowing costs in an economy will be affordable if banks can subsidize losses of non-performing loans with the profits from performing loans Diamond (1984). How many bad loans are too many for a bank? This question is addressed in Chu (2023). In general, if the profits of performing loans are not enough to cover the costs of holding non-performing loans, holding non-performing leads to universally detrimental results, from forcing small bank liquidation to compromising financial stability.

If large non-performing loans are damaging, an intuitive ex-ante solution is to screen the

borrowers and reject those likely to become non-performing loans. This is the active banking practice that we study in this paper. Our study also analyzes alternative liquidity suppliers of convertible and venture capital funds due to different cashflow rights. Our goal is to explain two stylized facts unaddressed in the literature, (1) Why do only part of the firms have debt access? (2) Why is one form of external liquidity realized from alternatives?

We solve the convergent decisions of liquidity supply and demand through extensive-form games. The first external liquidity is credit lines. As a first mover, a firm will apply for credit line access on two occasions. The company has experienced unexpected liquidity shortages. Or, it would pay commitment fees to protect a low-probability shock. Banks choose between granting and declining after reviewing applications. Either choice maximizes a bank's interest. Our analysis yields three predictions.

First, the base prediction is about the priority of liquidity needs. Companies must prioritize current liquidity needs over new projects. If a company reports negative net income and has a positive NPV project in the same period, the latter should be passed on if the available liquidity can only meet one need. Here are two reasons. First, current operations are essential to maximize a company's future value. Without paying suppliers, value maximization exercises will be jeopardized. Credit lines are perfect solutions. Second, being under construction, the new project cannot generate sales revenue. The base prediction leads to the next two predictions.

The second prediction explains the distribution of credit line access. Of all the firms in an economy, our model separates firms with access to credit lines from those without access. Firms with access to credit lines share two characteristics. They have experienced unexpected liquidity shortages. Banks evaluate that a borrower's historical operating income is healthy enough to guarantee drawdown interest rate payments and principal repayment at maturity.

However, companies do not have access to credit lines for different reasons. Firms with sufficient net income may not need credit lines in the first place. Active banks can reject liquidity demand. The firms that demand credit lines the most are those that regularly report negative net income. Bank rejection is justified because firms' operating income cannot satisfy the debt

payments. Banks will also reject companies that pay commitment fees but rarely draw down the lines because the commitment fee cannot justify the cost of bank capital required by the Basel off-balance-sheet commitment inclusion.

Third, our model predicts alternative access to term loans or convertible debt when entrepreneurs take on additional projects to expand their existing operations. Banks will reject term loan access if an applicant's operating track record is poor. When a new project is under construction, existing operating income is the only source for term loan coupon payments.

However, being rejected on term loans, an applicant can access convertible debt under one condition: strong growth. The difference is, again, the exchange of rights and responsibilities. Because convertible funds share the rights of future cash flows of the borrower much longer than N years after conversion, coupon rates for convertible debt are much more affordable.

We empirically test our model prediction on credit lines. We study credit lines instead of term loans and convertible debt because of the former's identification advantage. Unlike term loans or convertible debt, a credit line contract separates drawdown decisions from contract establishment. By contract obligations, banks must honor drawdown requests. In other words, the borrowers drive drawdown variations.

To study comprehensive drawdown decisions, we perform a two-step data work. In the first step, we start with all companies from 2005 to 2007 to identify the distribution of credit line contracts. We have found that 655 of 3400 companies signed 95% of the new credit line contracts in dollar amounts between 2005 and 2007. In the second step, we will study the drawdowns of the 655 regular borrowers.

The realized contract distribution has two characters. First, only a part of the firms have access to credit line contracts. In our model prediction, this cross-sectional difference should be a general equilibrium. Second, the difference between firm A with and firm B without access indicates different regimes of internal liquidity of the two firms. We document four pieces of empirical evidence. First, the status of with or without access to credit line contracts is sticky, which lasts for a number of years.

Second, firms without access to credit lines report polarized internal liquidity. Define internal liquidity as the sum of cash holdings and $EBIT$. Set the average internal liquidity of firms with access to credit lines as the internal liquidity reference. Of the 1,900 firms without a history of access to credit lines, about 1,000 firms report internal liquidity 30% higher than while the internal liquidity of the remaining 900 firms is 15% lower than the liquidity reference.

The internal liquidity of the 1,000 firms accounts for 68% of their non-cash assets (median). With abundant internal liquidity, we cannot reject the two model predictions. Firms with sufficient internal liquidity will not apply for access to credit lines. Even if they do for insurance purposes, banks will turn down their applications because they will unlikely draw down, yet banks must commit their precious capital for the off-balance-sheet commitment.

Third, we document three unconditional bank rejections. We dropped 227 firms from the 3,400 firm samples due to low collateral concerns. 225 firms did not have credit line contracts from 1995 to 2007. Furthermore, banks do not grant credit line access if applicants report low returns on assets or high volatility in cash flows.

Fourth, we document conditions for bank approval. Results are different in two subgroups. A firm is in the high (or low) internal liquidity subgroup if its internal liquidity is greater (or lower) than the internal liquidity reference. Of the two internal liquidity sources, we analyze $EBIT$ and cash holdings separately. When applicants come from the high internal liquidity subgroup, banks grant access to companies that lack cash holdings; These companies are not short of cash flows ($EBIT$). However, when applicants come from the below reference subgroup, banks grant access only to applicants with significantly higher cash flows ($EBIT$).

After establishing that credit line contracts are convergent decisions of firms and banks, we move on to analyze drawdown variations. This is our identification of a demand-side shock. With a contract, it is the borrower's decision when to draw and how much; banks must honor every request to fulfill their contract obligations. Therefore, credit line drawdowns allow a clean separation of the demand side story from the lending channel literature.

However, the identification advantage comes with a challenge. There is no commercial data

reporting credit line drawdowns. We overcome the challenge by collecting information from 10-K by hand. Specifically, we design a six-question questionnaire and collect responses from 655 regular borrowers in 2008 and 2009[1]. We collect both (a) hard information (outstanding and drawdown amount) and (b) soft information (a company's official views on liquidity).

Back to basics, regular borrowers only drew down about 25% of their outstanding credit lines in 2008 and 2009. Furthermore, the 10-K narratives indicate that internal liquidity is their number one source of liquidity. They do not have difficulty accessing external liquidity and do not replace insolvent banks. Together, quantitative and qualitative information supports an independent story of demand shock.

We further test whether the 25% dradowns are sufficient to neutralize internal liquidity shortages. This is important to relieve concerns about a lending channel story if drawdowns are insufficient to fill in internal liquidity gaps. The regression results confirm, again, the demand side story. With drawdowns, companies are not short of total liquidity. If we add undrawn amounts, the total liquidity of regular borrowers becomes overflows. Furthermore, companies above the internal liquidity reference drew down less. In sum, fractional drawdowns satisfy borrowers' liquidity needs.

Here is the contribution of this study. We model ex-ante a fair financial contract between liquidity demand and supply on three assumptions. On the demand side, firms are exposed to stochastic income. Active liquidity suppliers can reject applications or grant access. Agents on both sides maximize their own interests. We offer an equilibrium explanation for the total liquidity management for *all* companies. Why do some, but not all, firms have liquidity contracts? Why do firms have access to credit lines, term loans, or convertible debt?

The model in this study offers conforming explanations for the liquidity triangle of cash holdings, operating income, and credit lines. Our study can consolidate the arguments and evidence of existing studies that have analyzed one or two inputs of the liquidity triangle. For

[1]We code information from the section on Liquidity and Capital Resources from 10-K, Item 7 Management's Discussion and Analysis of Financial Condition and Results of Operation.

example, firms should rely on credit lines over internal cash (Kashyap, Rajan, and Stein, 2002; Gatev and Strahan, 2006). However, banks only grant credit lines to companies that maintain high cash flows (Sufi, 2009). U.S. industrial firms, on average, have held much more cash since 1980 (Bates, Kahle, and Stulz, 2009). Cash holdings are a buffer for cash flow shocks and credit lines support future business opportunities (Lins, Servaes, and Tufano, 2010). About a third of companies have zero or negative net debt (Strebulaev and Yang, 2013). In the textbook (Berk and DeMarzo, 2017, page 615), more than 75% of corporate investments are funded by retained earnings. Firms substitute credit lines for cash holdings (Nikolov, Schmid, and Steri, 2019).

Our paper has revealed a demand-side story in debt borrowing in three stages. The separation of drawdowns after contract establishment offers the foundation for our exercises. First, by contract obligation, banks must honor drawdown requests from borrowers to perform a fair exchange of rights and responsibilities. Second, the unique 10-K data collections strengthen the demand side arguments from quantitative and qualitative perspectives. Third, regression analysis confirms that fractional drawdowns are sufficient to fill in companies' internal liquidity gaps. Our demand-side story complements the established supply-side shocks in the lending-channel literature. See, among others, Campello (2002), Calomiris and Mason (2003), Ashcraft (2005), Khwaja and Mian (2008), Paravisini (2008), Leary (2009), Chava and Purnanandam (2011), Puri, Rocholl, and Steffen (2011), and Schnabl (2012).

Drawdowns and surveys are two empirical tools applied in the literature. Ivashina and Scharfstein (2010) analyzed drawdowns but with a research agenda different from ours. They documented the drawdown externality of Lehman's bankruptcy. (Lins, Servaes, and Tufano, 2010; Campello, Giambona, Graham, and Harvey, 2011) surveys CFOs to study credit lines. Our surveys collect quantitative and qualitative information related to credit line drawdowns from companies' 10-K.

The paper develops as follows. In Section 2, we model liquidity supply and demand through extensive-form games. Section 3 is hypothesis development. Data construction is in Section 4. Empirical evidence is given in Sections 5 and 6. We conclude in Section 7.

2 Balance Rights & Responsibilities of Liquidity Demand and Supply

The literature on corporate liquidity management is built on the seminal work of Holmström and Tirole (1998), henceforth *H&T* model. Firms explore optimal cash holdings to meet future cash outflow needs for investment opportunities. Furthermore, a financially constrained firm may need to save cash flows for its investments for today and tomorrow (Almeida, Campello, and Weisbach, 2004). Debt issuance has a disadvantage than cash because debt financing may not be available when a firm needs it the most. Lines of credit solve the problem of debt issuance. Paying a small fee, the borrower has secured a bank's commitment to lend in bad times, otherwise the firm could not borrow (Boot, Thakor, and Udell, 1987).

The literature has also documented why companies drop out of credit line accesses. Firms must maintain high cash flow for credit lines (Sufi, 2009). Although our knowledge has advanced, the literature lacks a "unifying theory" that explains the interaction between internal and external liquidity (Campello et al., 2011). Readers may refer to Almeida et al. (2014) for a comprehensive review of theoretical and empirical studies on liquidity management and the development of access to credit lines.

2.1 Our research question

H&T model has thoroughly analyzed why entrepreneurs demand external liquidity. In this study, we add the rights of outside liquidity providers to the analysis equation[2]. To be fair in the ex-ante contract design, we balance the rights and responsibilities of both liquidity supply and demand sides. Here is our main research question. What are the converged liquidity decisions if agents of liquidity demand and supply maximize their long-term asset value?

[2]The liquidity providers are "outside investors" on page 7 of *H&T*.

2.2 Agents maximize future assets

We model that all agents operate risk-taking businesses and grow their future assets. Entrepreneurs or banks are agents. We define a project as "risk-taking" if the expected returns of the project developed by entrepreneurs or the loan originated by banks are higher than the risk-free rate of returns. Maximization exercises are given in Equations (1) to (3).

We start with a single risk-taking project and an agent in the economy and assume that this project can operate for a sufficiently long period. The agent operates this project that generates net income (NI_t)[3]. Operating ongoing businesses, the agent plans the necessary cost of sales ($Cost_t^{sales}$) and operating expenses ($OpEx_t$). Costs and expenses are relatively stable, unless agents want to expand the production line, which includes products or services.

$$NI_t = EBIT_t - IR_t - Tax_t;\ EBIT_t = Rev_t - Cost_t^{sales} - OpEx_t. \tag{1}$$

$$ROA_t = \frac{NI_t}{AT_t};\ dROA_t = \mu dt + \sigma dW_t. \tag{2}$$

$$\begin{aligned} \max_{\mu,\sigma} \quad & E\left[AT_0 \times (1 + ROA_t)^T\right] \\ \text{s.t.} \quad & AT \times \mu > IR + Cost + OpEx, \\ & \text{economic constraints at every } t. \end{aligned} \tag{3}$$

However, due to the nature of risk taking, sales revenues (Rev_t) are volatile. Therefore, $EBIT_t$ and NI_t vary over time. We model the return on assets (ROA_t) and the return on equity (ROE_t) following a mean-reverting stochastic process in Equation (2)[4]. Mathematically, we can measure this process by the expected return (μ) and return volatility (σ). The normal

[3] Accounting definitions follow (Berk and DeMarzo, 2017, Section 2.4, page 64). *Net Income = EBIT - interest expenses - corporate tax* (Table 2.2, page 63). IR_t is interest expense. Tax_t is corporate tax. *EBIT = sales revenues – cost of sales - operating expenses*. The cost of sales is the direct production cost. Operating expenses are ordinary costs of running the business but are not directly related to production. For the sake of modeling, we ignore entries of noncash accounting adjustments, such as depreciation and amortization, other noncash items, cash effect of changes in accounts receivable, payable, and inventory

[4] $ROA = \frac{\text{Net Income + Interest Expenses}}{\text{Book Value of Assets}}$ (2.21, page 77); For an agent operating a business without debt, the return on equity is $ROE = \frac{\text{Net Income}}{\text{Book Value of Equity}}$, (2.20, page 76).

professional career of an individual is about 40 years, starting at 23 after graduating from a university and ending at 65 of retirement. Because the professional career (T) is shorter than the risk taking project, the agent can maximize its long-term assets by $AT_0 \times (1+\mu)^T$.

Next, we extend our analysis to I agents ($I > 1$) and J projects ($J > 1$) in an economy. We define the product lifecycle as shorter than the career duration of entrepreneurs. The product lifecycle is measured by maturity (m_j) from the initial concept to product retirement. The duration of a professional career is a finite large number T. The three extensions, $I > 1$, $J > 1$, and $m_j < T$, bring our model closer to reality for two reasons. The typical product lifecycle spans several years. Despite the normal 40 years of professional career for one generation, T can be a multiple of 40 years if the risk-taking business is transferable from one generation to another. Therefore, the updated solution for agent i will be in Equation (4).

$$\text{Agent } i : \sum_{j=1}^{J} AT_{i,0} \times (1+\mu_j)^{m_j}, \text{ where } \sum_{j=1}^{J} m_j = T. \tag{4}$$

The update has a few new perspectives. In Equation (4), maximization exercises become repetitive two-part operations. In a specific period, an agent i chooses one of the available projects. Throughout the professional career, an agent accumulates the future value of his/her assets based on the chosen projects.

Why future value? To better address the question, we distinguish utility from utility function. Following the literature, we assume that all agents recognize constant relative risk aversion (CRRA) as their utility function. We interpret CRRA as the risk attitude of agents towards the *returns* of risk-taking projects[5]. However, we use the utility to describe happiness, measured by an agent's assets, throughout the agent's professional career.

There are two reasons why maximizing discounted future value is a suboptimal choice. The answer is $\sum_{j=1}^{J} m_j = T$. Because $T > m_j$, an agent cannot foresee future opportunities. When an entrepreneur develops an early project, he or she does not know what the next project

[5]For example, for a project with a long-term mean return of 11%, agents book certainty equivalent returns internally lower than 11%. The higher the risk-averse coefficients, the lower the certainty equivalent returns.

will be. Successfully achieving small projects can set the stage for future projects demanding risk-taking at a higher level. Here is Example A[6]. On the other hand, a project with higher returns (μ) is associated with high risk (σ). A project with higher risk indicates that in certain periods, the income can be significantly lower. Furthermore, income shocks are unexpected. Bankruptcy will occur if the shock is greater than the income. Here is Example B[7].

Therefore, the utility is maximized by three variables T, μ, and σ, but only two choices, as we will discuss next. If choosing a short T, an agent choosing a higher μ will be happier if, luckily, he/she is not hit by shocks. However, the same happiness can be achieved by choosing a longer T and a lower μ. The lower risk in the longer term could make an agent even happier than the agent choosing high μ and long T. However, the combination of longer T and higher μ is a challenge for most agents due to the volatility of the returns σ, as shown in Example B.

Every entrepreneur endogenously chooses T and μ. Most agents choose a project due to the attractive μ. However, σ is an association once μ has been selected. The choice between long and short T has economic meaning on two fronts. By choosing a lifelong investment period, the long T, an entrepreneur will experience episodes of economic expansions and recessions. In between are financial crises. Therefore, the agent will be better off not choosing high μ projects during recession episodes due to elevated risk. Aiming for earlier retirement, shorter T, an agent can gamble in the absence of shock and choose high-return projects.

However, banks do not choose T or μ in bank loan business. This is because the bank's utility maximization is built on the foundation of improving the efficiency of debt intermediaries. We will turn to two-tier bank utility maximization in Section 2.7.

[6]Under Steve Jobs' leadership, Apple introduced Macintosh in 1984, iMac in 1998, and iPod in 2001. Jobs announced the change in company name from Apple Computer, Inc. to Apple Inc. and iPhone in 2007. Wikipedia: Apple Inc.

[7]Since three Lehman brothers, Henry, Emanuel, and Mayer, founded Lehman Brothers in 1850, the company accumulated asset growth by choosing different risk-taking projects. However, after choosing the high μ of mortgage exposure (1997-2006), the company filed for bankruptcy in 2008 after the collapse of the subprime mortgage markets. Wikipedia: Bankruptcy of Lehman Brothers

2.3 Right and obligation differences are the economic constraints

We turn to two constraints in Equation (3). The first is the profitability constraint. To survive and grow, all agents must make profits. The estimated ex-ante project return ($AT_i \times \mu_j$) must be higher than the cost of borrowing (IR_i), costs of sales ($Cost_i^{sales}$), and operating expenses ($OpEx_i$).

There are two layers of economic constraints. On the top layer, no business owner can continue operations without paying its suppliers. Therefore, access to external liquidity becomes essential when an entrepreneur is exposed to liquidity shortages. This is the second layer, which has been thoroughly studied in the literature.

However, whether a liquidity contract can be established depends on the balance of rights and responsibilities of different agents. This is the focus of this study. The cash flow rights of operating profits or losses differ for business owners, creditors, and equity holders. Different payoffs between debt and equity are elaborated in Merton (1974). Myers and Majluf (1984) has extended the differences of cash flow rights to internal cash and convertible debt.

Here is an example to illustrate the differences in cash flow rights, risk, and investment horizon. Assume that the true cost of a term loan for a project is 8% for 3 years, according to the estimates of a business owner. After the completion of the project, the owner will keep operating the project as long as sales are profitable. An external liquidity provider would ask for different coupon rates or yields by offering conventional debt, convertible debt, or equity financing. Due to the default risk within 3 years of project development, the coupon rate for external debt will be higher than 8% because the creditor needs to save the risk premium embedded in the coupon payments in the first half of the debt tenor to recover the expected losses of the principal if a default occurs in the second half. However, due to a conversion of rights to share future cash flows from the project after 3 years, convertible debt will demand coupon rates much lower than 8%. At the other end of the risk spectrum, the coupon rate of an equity injection is zero due to perpetual rights to share cash flows.

2.4 Three assumptions for an ex-ante fair liquidity contract

In the *H&T* model, there are three periods, ($t = 0, 1, 2$), and two agents, a firm (entrepreneur) and an investor (consumer). The firm has an endowment $A > 0$ and considers an investment project at $t = 0$. The firm does not have endowments at $t = 1, 2$. The capital of the investment (I) at $t = 0$ is higher than the entrepreneur's endowment, $I > A$. ρ is the liquidity shortage per unit of investment at $t = 1$ with a probability of λ[8]. Naturally, the entrepreneur invites the external investor. R is the investment return if the project succeeds in $t = 2$.

In the moral-hazard model, entrepreneurs can behave or shirk. If an entrepreneur is diligent, the probability of success is high p_H. Or the owner shirks, the probability of success is low $p_L < p_H$, but the entrepreneur enjoys a private benefit B.

In sum, firms in an economy are net borrowers $I - A > 0$. Once a project is financed, the necessary and sufficient conditions for continuing a project are $p_H R \equiv \rho_1 \geq \rho$. The investor is paid $\rho_0 \equiv p_H[R - (B/\Delta p)]$ at $t = 1$, where $\Delta p = p_H - p_L$. The entrepreneur is paid by $\rho_1 - \rho_0 = p_H(B/\Delta p)$. Without a positive wedge $\rho_1 - \rho_0 > 0$, an investment will be self-financed and could be in arbitrarily large amounts.

Recognizing that the *H&T* model adequately recognizes the interest of entrepreneurs, we take three assumptions.

Assumption 1. *Any risk-taking business generates stochastic operating income;*

Assumption 2. *External liquidity providers are active;*

Assumption 3. *The liquidity demand and supply sides fairly exchange rights and responsibilities.*

Assumption 1: The operating income of any risk-taking business is uncertain. Assumption 1 captures the nature of risk taking. Assumption 2: The external liquidity providers are active. Holmström and Tirole (1998) suggests active liquidity provider as a future research direction.

[8] Following (Holmström and Tirole, 2011, page 32), we can interpret I as the cost of purchasing a machine and ρ is the variable costs of production including working capital, labor, and rental for the production factory.

We allow both sides of liquidity demand and supply to maximize their own interests. In order to establish an ex-ante equilibrium financial contract, the liquidity demand and supply sides must maintain fair exchanges of rights and obligations. This is Assumption 3.

We map banks that originate credit lines and term loans to the external liquidity supply in the *H&T* model. In our model, external liquidity suppliers also include equity-related funds such as convertible funds and venture capital funds. The difference is the cash flow rights. Banks have debt rights. However, external liquidity suppliers with equity features have cash flow rights of the operating income of entrepreneurs.

Here is the rationale for assumption 1. Because T is ongoing, entrepreneurs plan direct or indirect operating costs. However, sales revenues vary over time with uncertainty. By uncertainty, we follow the convention that neither entrepreneurs nor external liquidity providers can predict the exact operating income in the next period. However, all agents know historical operating income from published financial statements.

The rationale of Assumption 2 is that liquidity providers ensure that revenue income is higher than whichever is higher: their costs of capital and premium of the liquidity demand. The main difference between the different liquidity securities is the cash flow rights and responsibilities. We analyze two types of external liquidity: bank loans and convertible debt.

Our alternative assumptions are consistent with empirical evidence, regulatory guidance, and theoretical arguments. The general consensus is that not all firms have access to debt. Among others, Strebulaev and Yang (2013) documents that 32% of the firms reported zero or negative net debt between 1962 and 2009. Furthermore, 61% of firms without debt are not inclined to borrow in the next year. In the textbook of (Berk and DeMarzo, 2017, page 615), more than 75% of corporate investments have been funded by retained earnings since 1990.

Moreover, it has become the industrial standard that banks shall not grant a borrower access to term loans or credit lines without examining the borrower's track record. Due diligence practice has been enhanced by regulatory bodies. In BIS bcbsc125, it is emphasized that loan origination should be operated "under a sound credit granting process". In EBA GL 2020 06,

banks should have internal governance in relation to credit granting and monitoring.

The credit granting process has its theoretical roots in Diamond (1984), which proposes and addresses two questions. First, it is quite expensive for households to monitor entrepreneur borrowers to address the risk that some do not pay coupon payments due to risk-taking failures or cheating. The solution is that households should hire a specialist bank to monitor borrowers. But here comes the second problem; Who monitors the monitor? The solution is that banks make many loans to different borrowers. Therefore, the losses of non-performing loans will be covered by the income of performing loans, so borrowing costs will be reduced.

Diamond (1984) describes a general equilibrium of bank loan portfolios. At any time, there are some bad loans held by some banks in the banking system. Chu (2023) asks a follow-up question. How many bad loans are too many? Here is the short answer. The bad loans become unsustainable if the profits from performing loans are insufficient to cover the losses of non-performing loans. The negative results vary, which can force small bank liquidation or impair the function of maturity and risk transformation at the banking system level.

To proceed, we use Sections 2.5 to 2.6 to demonstrate Assumption 1 in the decision making of the liquidity demand. We use Section 2.7 to demonstrate Assumption 2 in the decision making of the liquidity supply. We use Section 2.8 to demonstrate Assumption 3 through which a liquidity contract is fairly established.

To demonstrate the impact of uncertain operating income, we replace three dates, date $0, 1, 2$, in the $H\&T$ model with three stages. Each stage can include more than one period, and one period is one quarter. Here is an example. A company i is operating its existing business. The company has a new investment plan to strengthen its competitive advantage. The conditions $(\rho_0 < \rho < \rho_1)$ hold. The company submits a credit line application in October 2023 for the new project. The credit line limit is CL_i dollars.

Stage I ends at the end of December 2023, within which the bank decides whether to grant access or reject the application. If approved, the amount is available for drawdown from Jan-

uary 1, 2024, to December 31, 2026[9]. Stage II includes $N = 12$ quarters and four pieces of information that are relevant. Keep operating current production lines; develop the new plant without sales; pay the commitment fees since January 2024 and interest rates after drawdown; publish 12 quarterly financial statements. Stage III starts from 2027Q1, when the firm will announce the first sales of the new product. The firm will continue to operate the project if initial sales are booming. Otherwise, the plant will be shut down.

2.5 Stochastic operating income and liquidity priority

When an entrepreneur operates an ongoing business, the direct and indirect costs of operating activities are paid at the beginning of the quarter t; still sales revenues are realized at the end of t. The nature of risky business operations has two characteristics. First, sales revenues could be higher or lower than the costs paid in a quarter. Second, either a liquidity surplus or a shortfall surprises any economic agent. In short, $EBIT$ can be positive or negative in time series due to stochastic operating income.

$$FCF_{i,t} = EBIT_{i,t} \times (1 - \tau_c) + Depr_{i,t} - CapEx_{i,t} - \Delta NWC_{i,t}. \tag{5}$$

In Equation (5), we analyze the decision to allocate free cash flows and show why stochastic operating income can change entrepreneur decisions. Ina specific t, say 2024Q3, the credit line (CL_i) is scheduled to cover the capital expenditure ($CapEx_{i,t}$) of the new plant. However, the company is exposed to a negative EBIT ($NEBIT$) in the same quarter. CL_i is enough for one liquidity demand but not for both, shown in Equation (6).

$$CL_i > CapEx_{i,t} \; or \; CL_i > |NEBIT_{i,t}|; \; but \; CL_i < |NEBIT_{i,t}| + CapEx_{i,t}. \tag{6}$$

Furthermore, the company does not have additional liquidity access in 2024Q3. In this case,

[9] In Section 2.9, we replace the credit line contract with a term loan contract for a new investment project.

what liquidity needs should the company prioritize? With rational behavior, the company must prioritize the liquidity need of $NEBIT$. Otherwise, the economic constraint becomes binding. Without payments, suppliers will suspend their products or services. Long-term optimization of the company i in Equation (3) will be compromised. Therefore, the company i bypasses the positive NPV project ($CapEx_{i,t}$) in 2024Q3.

2.6 Stochastic operating income in all t at stage II

We classify all firms into two types based on historical operating income. Type I firms are not interested in applying for credit lines because they report positive internal liquidity most of the time. For the sake of analysis, we set 97.5% of quarterly observations with positive $EBIT$ as the cut-off percentage point for Type I firms.

Therefore, the rest of the firms report a positive $EBIT$ less than 97.5% of the quarterly observations. These firms have experienced internal liquidity shortages. They are Type II firms. Being short of internal liquidity, firms seek access to credit lines. However, credit lines come with a cost with direct and indirect components. Direct costs include monetary expenditures and wages for human resources to prepare for the application. Indirect costs include the disclosure of private information about the firm's business operations[10].

All Type II firms will draw down the lines if a contract has been approved. We can further separate firms into Type IIA and Type IIB. The difference is that Type IIB firms are unlikely to service the drawdown interest rate payments and principal repayment due to their historically low operating income. To be "unlikely" to fulfill drawdown obligations, we set positive $EBIT$ quarterly observations below 25%.

We illustrate the distribution differences in internal liquidity for all companies in Figure I. Figure (A) is an example of Type I firms. Its internal liquidity distribution features $\mu_{ebit} - 1.96 \times \sigma_{ebit} = 0$, or positive $EBIT$ in most (97.5%) of its operation history. Figure (B) illustrates

[10]Revealing liquidity shortages could have negative effects as supplies may withdraw from the established business relationship, and firms are forced to replace suppliers.

an example of Type IIB firms. Based on $\mu_{ebit} + 0.67 \times \sigma_{ebit} = 0$, the firm reports negative $EBIT$ in 75% of the quarterly observations. Type IIA firms report positive $EBIT$ quarterly observations between 25% and 97.5%, not shown in the figure.

Equation (7) quantifies different liquidity situations by meter number to satisfy the liquidity constraint in Equation (3). A firm scores a positive meter number if the owner expects sufficient internal liquidity for the next quarter. With the experience of insufficient internal liquidity, a company applies for credit lines at a cost. However, a positive meter number will increase a firm's liquidity if the credit line application has been approved.

$$\text{Firm liquidity meter} \begin{cases} \text{-2 pts:} & \text{internal liquidity is insufficient;} \\ \text{-1 pt:} & \text{cost of applying for external financing;} \\ \text{1 pt:} & \text{internal liquidity is sufficient;} \\ \text{3 pts:} & \text{external debt application has been approved.} \end{cases} \tag{7}$$

The liquidity meter number emphasizes the liquidity status in relation to the liquidity constraint in Equation (3). Maximizing his or her growth goal in Equation (3), the ideal liquidity status of all entrepreneurs is liquidity *neutral* (liquidity meter $= 0$) in any quarter in Equation (5). However, neutrality is ephemeral because entrepreneurs take risks and grow their assets.

Sufficient internal liquidity has one point, 1 pt. Both insufficient internal liquidity and costs to apply for external liquidity will be on the negative half of the liquidity meter. The cost of applying for external liquidity is -1 pt, and insufficient internal liquidity is -2 pts. Once the application has been approved, the liquidity meter will become neutral ($3 - 1 - 2 = 0$).

External sources have higher meters than internal sources because of efficiency. This model difference is consistent with theoretical and empirical studies. Credit lines are efficient liquidity sources (Kashyap, Rajan, and Stein, 2002; Gatev and Strahan, 2006; Sufi, 2009).

2.7 A bank's problem after receiving a credit line application

After the companies have submitted their credit line applications, banks practice two-tier utility maximization exercises. Please refer to Chu (2023) for details of the two-tier utility maximization. Ex ante, banks evaluate all received liquidity demand requests and choose to grant access or reject applications after due diligence. Rejection is justified if granting credit line access is inconsistent with the bank's best interest, to grow assets in the long term by practicing maturity and risk transformation. Please bear in mind that bank utility maximization is governed by the Basel capital adequacy ratio ($BaselR$).

Equations (8) to (11), the simplified version of Chu (2023), demonstrate how a bank practices the loan business and grows its assets. Bank net income (NT_{t-1}) is the income of bank loans ($AT_{t-1} \times BL_{bwr}$) net of bank funding costs by paying household deposits ($AT_{t-1} \times \beta \times FL_{td,t-1}$)[11]. Banks report positive net income when borrowers draw down loans and make timely interest rate payments. Positive net income increases bank equity capital (EC_{t-1}) and retained earnings (RE_{t-1}) from their previous levels of EC_{t-2} and RE_{t-2}. γ is the proportion transferred from net income to raise equity capital. At the end of $t-1$, banks can perform more maturity and risk transformation with higher capital in compliance with the Basel capital ratio.

$$\text{In the beginning of } t-1,\ BaselR = \frac{RE_{t-1} + EC_{t-1}}{AT_{t-1}}. \tag{8}$$

$$\text{At the end of } t-1,\ NI_{t-1} = AT_{t-1} \times (BL_{bwr} - \beta \times FL_{td,t-1}). \tag{9}$$

$$\text{If } NI_{t-1} > 0, EC_{t-1} = EC_{t-2} + \gamma \times NI_{t-1}, \text{ and } RE_{t-1} = RE_{t-2} + (1-\gamma) \times NI_{t-1}. \tag{10}$$

$$\text{At the end of } t-1,\ BaselR < \frac{RE_{t-1} + EC_{t-1}}{AT_{t-1}}.\ AT_t = AT_{t-1} + AT_{up} \tag{11}$$

[11] $BaselR$ is the Basel capital adequacy ratio. NI_t is the net income. AT_t is bank risk-weighted assets. BL_{bwr} is the coupon rates of bank loans charged to the bank borrowers. β is the proportion that a bank must borrow to finance bank assets $\beta = 1 - BaselR$. $FL_{bk,t}$ is the interest rate of the term deposits that banks can borrow from households. Since the duration of the bank loan (maturity) is longer than that of the term of household deposits, BL_{bwr} does not have subscript t. RE is retained earnings.

Equations (12) and (13) show why a bank reduces its assets. In the next t, some loans become non-performing. Furthermore, if the costs of holding non-performing loans are higher than the profits from the performing loans, net income becomes negative $NI_t < 0$. In this case, retained earnings must absorb losses ($NI_t < 0$). To comply with the Basel capital ratio, the bank must reduce its risk-weighted assets.

$$\text{If } NI_t \leq 0,\ EC_t = EC_{t-1} \text{ and } RE_t = RE_{t-1} - |NI_t|. \tag{12}$$

$$\because BaselR > \frac{RE_t + EC_t}{AT_t}.\ AT_{t+1} = AT_t - AT_{down}. \tag{13}$$

Negative net income indicates two cases that violate the profitability constraint of banks. In the first case, the borrower 1 (bwr^1) draws down the credit line (AT) and defaults ($BL_{bwr_1} = 0$). The bank has lost coupon income but has to pay the bank's funding cost. Type IIB firms could be bwr^1. To satisfy the Basel capital ration, banks must remove bwr^1's loan from their balance sheet. In case two, the borrower 2 (bwr^2) has paid the commitment fee but did not draw down. The bank received commitment fees ($Cmit_{fee,i} > 0$) instead of drawdown interest rates, $BL_{bwr_2} = 0$. Type I firms could be bwr^2. They do so to protect a small probability of liquidity shock. The ex ante solution is to reject credit line access to firms of Type I or Type IIB.

For each credit line contract a bank has approved, the bank must convert the off-balance commitment to on-balance risk-weighted assets. In doing so, the bank must allocate a piece of capital following the Basel capital requirements as in Equation (8), and secure funding liquidity[12]. Therefore, banks that maximize their long-term asset growth will commit their capital and sign loan contracts with firms that will draw down and it is unlikely that they will default. Type IIA firms are consistent with the best interests of banks.

We develop a net income meter to quantify the relative changes in a bank's net income to satisfy the profitability constraint in Equation (3). Rejecting a credit line (CL) application will not increase or decrease a bank's net income. Therefore, we set 0 pts as the reference.

[12]See paragraphs 313, 595, 599 and 604 in bcbs128, June 2006, Basel II: International Convergence of Capital Measurement and Capital Standards: A Revised Framework - Comprehensive Version

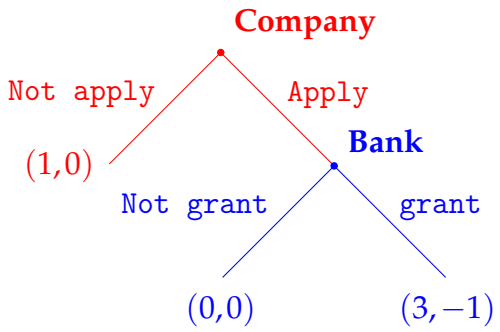
$$\text{Bank NI meter} \begin{cases} \text{-2 pts:} & \text{default after CL drawdown;} \\ \text{-1 pt:} & \text{no drawdown with CL access;} \\ \text{0 pts:} & \text{a CL application is rejected;} \\ \text{3 pts:} & \text{perform after CL drawdown} \end{cases} \tag{14}$$

A bank's net income increases by 3 points if the borrower draws down and performs. Otherwise, the bank must absorb losses from its net income, in Equation (14). The 1-point deduction refers to the nondrawdown case. A bank reports 2 points of net income losses due to a borrower's default. Because a bank makes many loans so that the performing loans cover the losses of non-performing loans Diamond (1984), the loan business is profitable by design. A performing borrower should contribute more to the income meter than the losses of a defaulted borrower. That is why $3 > |-2|$.

2.8 Credit line access: extensive-form game with stochastic EBIT

We analyze convergent decisions from liquidity demand and supply through extensive-form games. Companies and banks make endogenous decisions, which are sequential. The information is perfect and complete. A firm has two choices: to apply for or not apply for credit lines. Upon receiving an application, the bank grants access or rejects the application. Both players make their decisions based on the historical $EBIT$ of the firm and assume that the history is a fair estimation of the future. The games I and II show the decision process and the results of the credit line contracts of the Type I and Type II firms. In (#1,#2), #1 is for the firm and #2 is for the bank. The higher the meter number, the better.

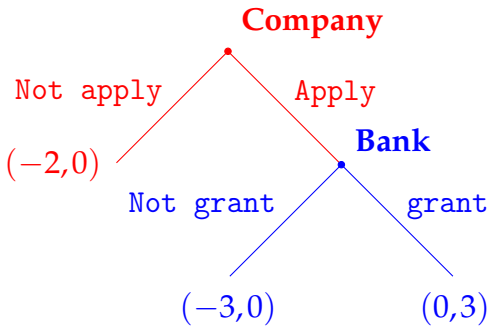
In equilibrium, Type I firms will not apply for credit lines. If a Type I firm applies and a bank grants access, the company liquidity meter will be 3 points. However, the chance that this company will draw the lines is slim, say 2.5%. On the liquidity supply side, the bank must commit equity capital once a credit line contract is signed, but it is unlikely to receive draw-



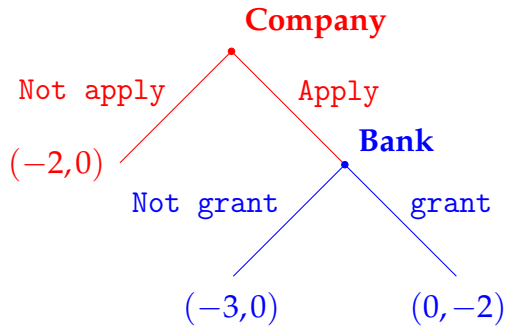
Game I. Type I companies and credit line contracts

down coupon income. The payoff for the bank is -1 points. Therefore, a bank that maximizes its best interest will not grant access to a Type I company.

The numbers of convergent meters of the firm and the bank are $(0,0)$. Between the choices of not applying and being rejected if applying, the better choice for the firm is not applying. Here is the equilibrium result. Type I firms that do not apply for credit lines. The meter numbers for the company and the bank are $(1,0)$.



(A) Type IIA company



(B) Type IIB company

Game II. Type II firms applying for credit lines

Although all Type II companies will apply for credit lines and draw down the lines if the contract has been approved, banks will not grant access to all applicants. In the game II(A), banks approve applications from Type IIA companies because historical $EBIT$ records show that these borrowers can pay their debt obligations. The convergent decisions are that companies apply for and banks grant access. The $(0,3)$ meters are superior to the choice not to apply $(-2,0)$. Companies can access credit lines to neutralize potential liquidity shocks with 0 points.

Banks report 3 points in net income.

The equilibrium option for Type IIB companies is "not apply". Compared to Type I and Type IIA firms, Type IIB companies demand access the most because 75% of their $EBIT$ are negative. However, the record shows that their income ($\overline{ROE}$) is lower than the necessary return (μ) to meet coupon payments and the principal payment at maturity; see Equation (15).

$$\overline{ROE} = \frac{1}{n}\sum_{t=1}^{n} ROE_t \ll \mu. \tag{15}$$

Banks will reject applications from these firms and the meter numbers are $(-3,0)$. By comparing the options of not applying $(-2,0)$, Type IIB firms are worse off if they choose to apply but are rejected $(-3,0)$ because application costs deteriorate liquidity shortages. Therefore, Type IIB firms rationally choose not to apply, as in the game II(B). Being constrained by external liquidity, as shown in meter numbers $(-2,0)$, these companies must save cash from cash flows. This is what is suggested in (Almeida, Campello, and Weisbach, 2004).

2.9 Firms with standalone investment projects

After entrepreneurs and banks have converged on their decisions about the liquidity demand and supply due to stochastic revenues, the next liquidity demand is for an additional investment project. If new investment projects are financed internally, the discussion of external financing is unnecessary. We focus on projects that need external financing in this section.

With insufficient cash (C), a firm applies to borrow ($I - C$) at Stage I. If a bank debt is approved, Stage II is devoted to the construction of the project. Therefore, no sales revenues are expected during Stage II[13]. The predicted probability of project success is p_H with the first year sales in stage III being S dollars with an annual sales growth rate of G. The expected cost of capital of the project is R_{pro}, and the entrepreneur wants to extract a rent B, in percentage. Of the choices between credit lines and term loans, companies are better off borrowing term loans

[13]The additional variable production costs ($I_{S2,t}$) can be nested in Section 2.6

instead of credit lines. This is because borrowers can save the undrawn commitment fees due to a scheduled plan of loan amount, maturity, and product sales,

After a firm has submitted a term loan application, a bank practices the same due diligence as for credit lines. However, there is one additional concern. A term loan could be significantly larger than a credit line ($I - C \gg CL$). Therefore, banks must evaluate the second hurdle in the principal payment. The first hurdle is still on cash flows for loan coupon payments. Before a project can generate sales, $EBIT$ from the existing operations is the only resource to service coupon payments. Is the historical $EBIT$ strong enough to meet the interest rate payments of the term loan? The cash flow hurdle is to review the track record of the borrower's operations. The condition of approval is captured by Equation (16)[14].

$$\frac{1}{n}\sum_{t-n}^{t-1} EBIT_t - IR_t - Tax_t > (I - C) \times BL_{bwr}. \tag{16}$$

The second hurdle is to evaluate the sales after the project is completed. Assume that new products or services are profitable. How long, in the number of years in Stage III, does the profit accumulation equal the loan principal? The forward-looking hurdle to principal repayment is captured in Equation (17).

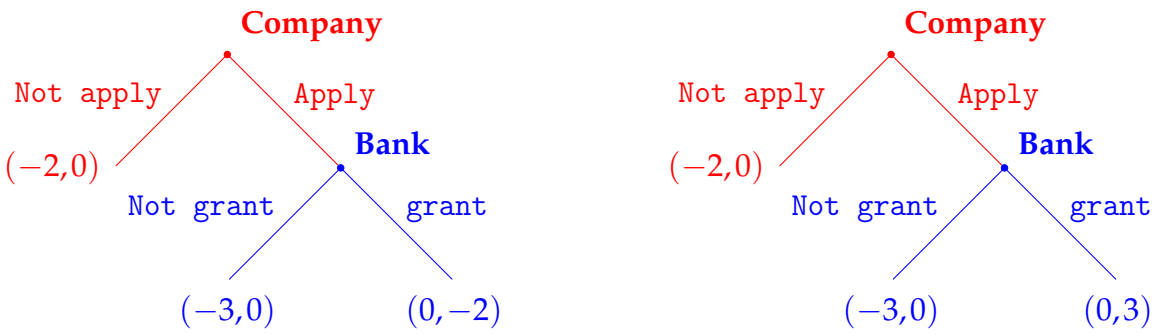
$$S \times [1 + \sum_{t=1}^{N} (1 + G)^t] \times [(R_{pro} - B) - BL_{bwr}] \times p_H > (I - C). \tag{17}$$

The origination of a term loan is rational if two hurdles in interest rate repayments and principal payment in Equations (16) and (17) are satisfied. On the contrary, a rejection is justified if neither hurdle condition is satisfied.

In the game III, companies with insufficient internal cash (-2 points) apply for term loans. In the game III(A), bank rejections are rational because the track record of borrowers could not satisfy the interest rate repayment or principal payment hurdles. Borrower defaults will

[14]The subscripts i of BL_{bwr_i} in Eqs (16) and (17) are omitted because both sides of each equation are the same borrower. For simplicity, historical $EBIT$s and the term loan principal are not discounted.

deteriorate the bank NI meter from 0 to -2 points. Therefore, bank rejection is rational. If bank rejection is expected, the second-best decision of firms is not to apply. This is because applying but not being granted deteriorates firm liquidity from -2 to -3 points. The convergent decisions with equilibrium meter numbers are $(-2,0)$. Companies do not apply for term loans.



(A) Company satisfies neither hurdles

(B) Company satisfies both hurdles

Game III. Both hurdles or neither hurdle satisfaction

In the game III(B), granting loan access is rational because two hurdles on cash flows and principal are satisfied in Equations (16) and (17). The convergent decisions with equilibrium meter numbers are $(0,3)$. Companies apply for, and banks grant access to term loans.

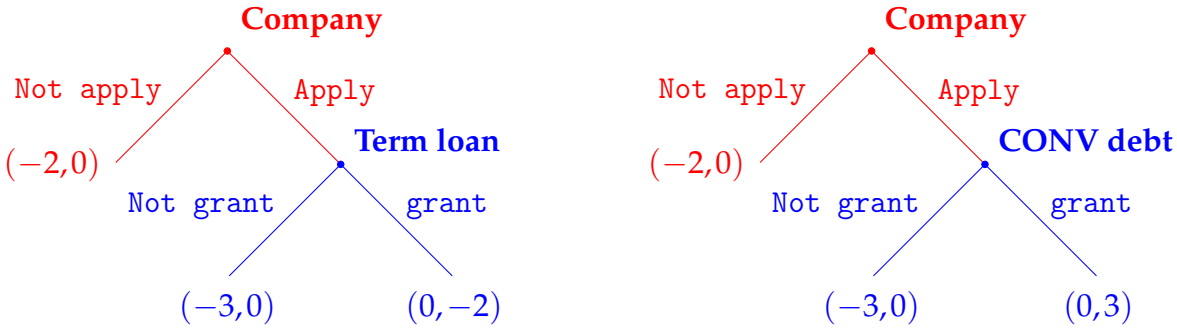
What if a term loan application satisfies one but not both hurdles? For bank term loans, the coupon payments and associated reinvestment income are lower than the loan principal. Therefore, a slow principal repayment is the main concern of banks.

Several factors contribute to concerns about principal repayment if profit accumulation is slow. For example, a new project with a low success rate ($p_L < p_H$) will need more years ($N^{p_L} > N^{p_H}$) of sales to satisfy Equation (17). Similarly, more years of sales are needed if a project has a low growth rate ($G^L < G$), the project's cost of capital is lower ($P^L_{pro} < P_{pro}$), or the business owner enjoys a high private benefit ($B^H > B$)[15].

The game IV captures the case that a company has a high expectation of sales of new products, but its historical cash flows cannot satisfy Equation (16). This type of company is usually

[15]Please note, charging a higher loan coupon rate ($BL^H_{bwr} > BL_{bwr}$) is not a solution to address the slow principal repayment for two reasons. First, term loans may be too expensive to afford, and $EBIT$ may be insufficient to satisfy Equation (16). Second, higher coupon rates could delay principal repayment; see Equation (17).

known as high-growth companies. We analyze converging decisions in term loans or convertible debt separately.



(A) Bank term loans **(B)** Convertible debt

Game IV. Poor cash flow history but high growth expectation on project sales

Due to historically low cash flows, high-growth firms cannot meet interest rate payments. Therefore, term loan applications are rejected; see the game IV(A). However, convertible debt could be the right liquidity supply. Convertible debt emphasizes long-term cash flow rights with two features. First, coupon payments in the first few years before project completion are low. Therefore, high-growth firms can meet the interest rate payment hurdle in Equation (16). Additionally, convertible debt suppliers can convert debt to equity to enjoy the high growth of new product sales. Convertible funds are happy to sign convertible financing contracts, as in the game IV(B).

3 Empirical Analysis and Research Design

The theoretical analysis in Section 2 predicts liquidity contracts converged by supply and demand sides on three debt instruments: credit lines, term loans, and convertible debt. Decisions on the demand and supply sides are endogenous. A debt contract is the convergent decision of the supply and demand sides. Each side maximizes its own interest. Neither side shall change its decision knowing the decisions of the other side.

When practicing empirical analysis, the hurdle that we must overcome is identification. In

the traditional lending channel literature, the hurdle is to identify supply shocks. However, the new findings that this study aims to reach are the story of the demand side on top of the supply side. Our exercises include two steps. In the first step, we choose to analyze credit line contracts and understand the contract distribution of all companies. In the second step, we focus on the drawdown results of those with credit line contracts.

As analyzed in Section 2, there are two reasons that companies do not have access to credit lines. Some companies are rich in internal liquidity, so they do not need external liquidity. Others are desperate for access. However, banks reject their demand requests because of concerns about the fulfillment of debt obligations. Therefore, we include all companies with or without access to credit line contracts in our empirical analysis.

After identifying the companies to be analyzed, we focus on the credit line contract because of its unique advantage in identification[16]. Accessing debt through a credit line contract works in two steps. The first step is the realization of the contract, and we propose three hypotheses. The second step is the drawdown decisions, and we will analyze them in Section 3.2.

3.1 Distribution of credit line contracts

The first hypothesis is about the recursive nature of credit lines. Credit lines are tools to address unexpected and recursive shocks of internal liquidity. A firm that has experienced internal liquidity shocks in the past few years is more likely to sign a credit line contract. When signing the contract, the firm expects unexpected liquidity shortages in the future.

Hypothesis 1: *Having access to credit lines is a status, and the status is persistent for several years.*

Hypothesis 1 is the direct results of Sections 2.5, 2.6, and 2.7. The second hypothesis is about firms' choices and active bank decisions (rejection). Companies that choose not to apply are Type I and captured in the game I. Companies that are separated for access but are rejected by active banks are Type IIB and captured in the game II(B). Type I and Type IIB firms do

[16] we leave the decisions on term loans and convertible debt for future studies.

not have access to credit line contracts. However, Type I companies have significantly higher internal liquidity than Type IIB companies.

Hypothesis 2: *The firms without credit line access demonstrate polarized internal liquidity.*

The third hypothesis tests the active bank hypothesis. Upon receiving an application, the bank will make admission or rejection decisions, and rejections are justified on three conditions. The applicants have low operating income, low tangible assets, or high income volatility. Low operating income or high income volatility will put drawdown interest rate payments at risk. Low tangible assets will make it more difficult for banks to recover the drawdown principal if default events occur.

Hypothesis 3: *Bank rejections are based on low income or tangible assets, or high income volatility.*

3.2 Drawdown decisions and regular borrowers

The second step is the drawdown decisions, which are unique to credit line contracts. Unlike the establishment of debt contracts, drawdown decisions are made solely by the borrowers. Credit drawdown decisions are also different from term loans or convertible debt because the latter two debt instruments are always convergent decisions from borrowers and banks. Only credit line contracts offer borrowers a two-step separation of drawdown activities from contract establishment. The borrowers decide when to draw and how much. Following the rights and responsibilities of the credit line contract, banks must honor drawdown requests, assuming that the requests are in compliance with the contract terms. Therefore, credit line drawdowns offer a clean laboratory for the demand-side hypothesis.

Hypothesis 4: *Credit line drawdowns of the regular borrowers demonstrate an independent demand side story in 2008 and 2009.*

However, when a bank becomes insolvent, the drawdown decisions of the contract borrowers are not honored. That is the only exception where a bank does not honor its contractual

obligations. Ivashina and Scharfstein (2010) has revealed the shocks from Lehman Brothers' bankruptcy filing on the drawdowns of the co-syndicated banks. The authors focus on the drawdown changes between December 2007 and December 2008 of 443 manufacturing firms from 37 banks with co-syndicated relationships with Lehman Brothers (Table 5). The authors have found that banks co-syndicated with Lehman experienced more drawdowns.

We study drawdown decisions with an agenda different from that in Ivashina and Scharfstein (2010) by answering two questions. How much did regular borrowers draw down their credit lines in 2008 and 2009? Whether the drawdowns can satisfy their liquidity needs? Because the drawdown analysis in Ivashina and Scharfstein (2010) covered 6% of the credit lines co-syndicated with Lehman Brothers (Table 3), we can patch the puzzle of a comprehensive drawdown picture of regular borrowers that account for the majority of the rest 94% of the credit line contracts. We employ the following strategies.

First, we identify all new credit line contracts in the DealScan database from 2005 to 2007. The sum of all new contracts of all borrowers in dollar amounts is the market value of the new contracts. Second, we focus on borrowers that account for 95% of the market value and define these companies as regular borrowers (with access to credit lines). Third, we manually collect drawdown information, which includes hard and soft elements. Hard information includes the dollar amount of total outstanding credit line contracts and the drawdown amount. We also designed a questionnaire to survey 10-K to locate the company's views on their internal and and external liqudities.

4 Data Construction

To search for answers, we start from all non-financial, non-utility firms in Compustat. A firm is included in our sample if it has no missing data on total assets (AT), long-term debt (DLTT), short-term date (DLC), cash flows (OIBDP) and cash holdings (CHE) in all three years from 2005 to 2007. 3,469 North American firms satisfy this condition. Following Sufi (2009), we

rank all 3,469 firms in size decile. The firm size is measured by the three-year average noncash total assets (AT – CHE). For firms in the smallest size decile, the mean of noncash total assets is $1.2 million. For firms in the largest size decile, the mean of noncash total assets is $29.216 billion.

Cash holdings and cash flows are two important sources of the firm's internal liquidity (Almeida, Campello, and Weisbach, 2004). We calculate the cash holding ratio and cash flow ratio to understand how much cash holdings and cash flows that firms in different size deciles have. The cash holding ratio is defined as cash holdings over noncash total assets, CHE/(AT - CHE). The cash flow ratio is defined as cash flow over noncash total assets, OIBDP/(AT - CHE). We calculate the cash ratio and cash flow ratio in 2008 and 2009 fiscal year and time series average for an individual firm. Holding firms constant in decile, we calculate equal-weighted average cash holding ratio and equal-weighted average cash flow ratio for firms in each decile. The equal-weighted cash holding ratio and cash flow ratio are plotted in Figure I, Panel A and Panel B.

[Insert Figure II about here]

There is a negative relationship between size and cash holdings in Figure 1 Panel A. The cash holdings of firms in the smallest size decile are the highest .[17] As firm size increases, the cash holdings decrease as a percentage of non-cash total assets. But there is a positive relationship between size and cash flows, in Figure 1 Panel B. Further, here is a unique detail in the relationship between cash flows and assets. Some firms report negative cash flows. More specifically, firms in the 1^{st}, 2^{nd}, 3^{rd}, 4^{th} decile report, on average, negative cash flows. Firms in the 5^{th} decile to 10^{th} decile have positive cash flows. This observation is consistent with 0.5%, 2.5% and 5% winsorization on both sides. More specifically, about 62.3% observations have negative cash flows in the bottom four deciles (decile 1 to decile 4), but 89.3% observations

[17]The ratio is winsorized at 2.5% on both sides. We also winsorize the cross-sectional cash ratio and cash flow ratio at 0.5% and 5% on both sides. The different levels of winsorization have different effects on firms in the 1^{st} decile and 2^{nd} decile only. For example, with 5%, 2.5%, and o.5% winsorization, the cash ratio for firms in the smallest size decile is 100%, 160%, and 400%.

have positive cash flows in the top six deciles (decile 5 to decile 10), in the 2008 and 2009 fiscal year.

Taken both Panels A and B together, there exists a negative relationship between the cash holding ratio and the cash flow ratio across ten deciles. This negative relationship is different from the concept in Almeida, Campello, and Weisbach (2004) that firms save cash from cash flows. Firms in the bottom four deciles have on average negative cash flows. Meanwhile, firms in the four bottom deciles have large cash holdings, which account for 100% to 50% of their noncash assets. It is reasonable that firms cannot save a large number of cash holdings from negative cash flows.

The above negative relationship suggests a substitution effect between two internal liquidity sources: cash holdings and cash flows. Firms that cannot generate positive cash flows need to hold a relatively large amount of cash. In this case, the source of cash holdings seems to come from somewhere else. The discussion of the source of cash holdings is out of the scope of this study (Denis and McKeon, 2020).

We take the firm's cash holdings as given. As firms can generate more cash flows, the needs to hold a large amount of cash seem to decrease. The substitution between cash holdings and cash flows is quite intuitive. Furthermore, this substitution effect suggests that internal liquidity is a sum of cash holdings and cash flows, and firms manage the internal liquidity on a pair of boundaries. On the one hand, the internal liquidity can't be lower than a lower bound. This is because internal liquidity is critical to support the routine production expenses. Assume a firm is unable to generate positive cash flows. This firm will cease to operate, dropping out of Compustat coverage, unless it has sufficient cash holdings. On the other hand, the internal liquidity should not be higher than an upper bound. This is because the excess liquidity would be a waste of resources. After all, excessive liquidity could be invested in risky projects to generate higher returns.

The intuition on substitution can be extended to the concept of total liquidity, a summary of internal and external liquidity. The lines of credit serve as external liquidity. To secure external

liquidity such as credit lines, firms need to pay for the commitment fee for the whole credit line even if they have not drawn yet. For specific drawn-down amounts, firms have to pay interest rates. Because external liquidity is costlier than internal liquidity, the pecking order theory predicts that firms would start from internal liquidity. If the internal liquidity is not enough, firms will resort to lines of credit as a supplement.

To analyze the substitution between internal and external liquidity, we need to know the firms with access and firms without credit line access. We search Dealscan with a focus on credit line facilities. In DealScan, we sum the dollar amount of credit lines for each borrower at Compustat GVKEY level each year. In total, 1,372 borrowers have signed $1.5958 trillion on lines of credit from 2005 to 2007. We rank all borrowers by their aggregated credit line contracts in three years. The borrowers ranked in the top 95% (bottom 5%) of the $1.5958 trillion are identified as regular credit line borrowers (as occasional credit line borrowers). There are 655 regular borrowers (coded regular CL) and 599 occasional borrowers (coded occasional CL). Mapping 1,254 DealScan credit line borrowers, we can allocate 3,469 firms into three groups. Four hundred fifty-eight firms are regular borrowers, 417 firms are occasional borrowers. These new credit line borrowers are in group one. Of the rest 2,588 firms[18] without new credit line access in DealScan from 2005 to 2007, 641 firms have unexpired credit line contracts signed between 1995 and 2004. These firms are in group two. The rest of the 1,947 firms have no history of credit line access and are in group three. We report the equal-weighted internal liquidity ratio, measured as the sum of cash holdings and cash flows scaled by noncash assets in 2008 and 2009, in ten deciles for firms in the three groups in Figure II.

[Insert Figure III about here]

There are three observations. First, firms in the 1^{st} size decile do not have new access or a history of access to credit lines. Second, from the 3^{rd} size decile onward, firms without credit line access have higher internal liquidity than firms with credit line access, either new or his-

[18]Six firms are dropped from 3,469 from 2002 to 2004. So, 3,463-458-417=2,588.

torical. Third, firms with regular new access are relatively large in the 7^{th} to 10^{th} size deciles. Taken Figure I and Figure II together, regular credit line borrowers are larger than the whole sample mean, have more cash flows, and have fewer cash holdings.

The second observation supports the pecking order theory. Because the lines of credit are more expensive, firms start from the cheaper source, internal liquidity. If internal liquidity is sufficient, firms don't need external credit lines. Only firms with insufficient internal liquidity would seek external credit lines. The first and third observations support the bank's role in the practice of credit line realization. Banks feel safe to do business regularly if credit line borrowers are larger in size and higher in cash flow. Figures I and II are equal-weighted averages, so some firms must report numbers lower or higher than the average. To better understand firms and banks' decisions, we proceed to the analysis on signing up credit line contracts.

5 Credit Line Contracts, Decisions of Demand and Supply

In this section, we document evidence on credit line contract realization. Our analysis is on both firms and banks. The realizations are in normal time without major financial crises.

5.1 The persistence of with or without credit line access

Of North American non-finance, non-utility firms in Compustat, there are 3,469 firms with no missing data on assets (AT), long-term debt (DLTT), short-term date (DLC), cash flows (OIBDP), and cash holdings (CHE) in all three years from 2005 to 2007. According to the history of access to lines of credit, we allocate all 3,469 firms into three groups. Group one, 875 firms have signed new contracts with lines of credit from 2005 to 2007. We further separate the 875 firms into two subgroups: 458 regular borrowers and 417 occasional borrowers. The former is regular (the latter is occasional) because they have signed 95% (5%) of the CL contracts in dollar amount from 2005 to 2007. Group two: 641 firms have unexpired contracts with lines of credit signed in the period of 1995-2004 but non-new contracts in the period 2005-2007. Group

three: 1,947 firms have no history of access to lines of credit in a 13-year window from 1995 to 2007. The 1,947 firms without a history of access to lines of credit in 13 years are the first piece of evidence supporting the hypothesis that without access to lines of credit is persistent.

Next, we show the persistence of access to lines of credit. The first is the firm number (Table I, Panel A). More than 520 of the 641 firms that signed contracts in the period of 1995-2004 but without signing new contracts from 2005 to 2007 have access to lines of credit in each year for a period of five years from 2005 to 2009. In other words, over 80% of the firms can access lines of credit in the second five-year window on the signed contracts in the previous decade. Furthermore, persistence is also observed among regular and occasional borrowers. At least 96% of the regular borrowers and 78% of the occasional borrowers have access to lines of credit in each year from 2005 to 2007. The ratio is even higher in 2008 and 2009.

The second perspective on persistence is from the credit line's dollar amount. All borrowers in the three groups have kept their outstanding contracts consistently, where the regular (occasional) borrowers report the highest (lowest) dollar amount, with the borrowers signing contracts from 1995 to 2004 in the middle (Table I, Panel B). Furthermore, borrowers in all three groups report about 14% to 39% higher dollar amounts on credit lines in 2009 than in 2005.

The credit line contracts offer generous credit to the borrowers. The contract amount accounts for 40% to 70% of the borrowers' noncash assets. Again, the consistency is observed in an upward trend. The contract amount as a percentage of noncash assets is higher in 2009 than in 2005 (Table I, Panel C).

[Insert Table I about here]

5.2 Internal liquidity and firms' choices

Firms are heterogeneous, and banks are selective. We take step-by-step work to understand the decisions of firms and banks gradually. In the first endeavor, we separate all North American non-finance, non-utility firms in Compustat into two sub-categories: high or low

internal liquidity. The internal liquidity reference (or liquidity reference for short) is defined as the three-year average, from 2002 to 2004, of the industry median internal liquidity. The internal liquidity of an individual firm is a sum of cash holdings (CHE) and cash flows (OIBDP) scaled by noncash assets (AT-CHE). We follow the Fama-French 12-industry classification. An individual firm whose average internal liquidity from 2002 to 2004 is higher than its internal liquidity reference belongs to the high internal liquidity group. Otherwise, the firm is in the low internal liquidity group. Firm separation, internal liquidity, and with or without credit line access are reported in Table II.

[Insert Table II about here]

The most notable are the high liquidity 3 firms in Panel A. These firms have the highest internal liquidity yet without credit line access. The median and mean internal liquidity of these firms is 68.3% and 115.4%. On the other hand, low liquidity 3 firms in Panel B have the lowest internal liquidity, with median (-0.1%) and mean (-84.7%). Furthermore, the high liquidity 3 firms in both Panel A and Panel B have no credit line access. Firms in high (or low) liquidity 1 and 2 all have credit line access. To sum up, the average internal liquidity of firms with credit line access clearly separates firms without credit line access. They have either much higher or lower internal liquidity than that of firms with credit line access.

In our analysis, firms without credit line access could have two different reasons. They have sufficient internal liquidity, so they do not apply, or they have applied, but banks turn down their applications. For firms with the highest internal liquidity yet without credit line access (High liquidity 3 in Panel A), the firm's own decision is more reasonable than alternatives. If these firms had applied, banks would have granted access. Granting access to these firms that will not drawdown is a risk-free business to banks because firms will pay commitment fees for the whole line amount during the entire tenor. All rest firms may apply for credit line access with similar reasoning because of lower internal liquidity. Table II also provides information on cash flows and cash holdings, which we will discuss, respectively.

5.3 Choices of active banks

If firms with a middle level of internal liquidity choose to apply for credit lines, there is no reason why firms that report bottom internal liquidity do not apply. Since they don't have a credit line history, alternative explanations beyond firms are worthy of investigation. Reviewing past financial statements, banks reject applications that may not service interest rate payments or make principal repayment. Empirically, we set $1 million of noncash assets as the collateral bar. Banks will not grant admissions for applicants with noncash assets lower than the collateral bar. Applying this filter, we drop 227 firms. 225 of the 227 dropped firms have no history of access to lines of credit. In other words, the low collateral filter has achieved 99% accuracy. The 225 low collateral firms have very negative cash flows, as shown in Table II, Panel B, Low liquidity 3[19].

Dropping 227 low collateral firms, we apply logit regression to test firms and banks' joint decisions. The dependent variable is *Access to LC*, a dummy variable equal to one for firms in High and Low liquidity 1 and 2, either signing new or having unexpired credit line contracts or zero otherwise. The main independent variable is *Internal liquidity* $((CHE + OIBDP)/(AT - CHE))$, and we add two control variables: *Size* $(log(AT - CHE))$, and *Market-to-book* $(AT - BE + PRCC\_F \times CSHO - CHE)/(AT - CHE))$. The two controls in Table III follow Sufi (2009) because the two variables are significant and consistent in all specifications. Because having access (or without access) to credit lines has persistence, the regression specifications are cross-sectional. For each firm, the value of independent variables is an average of a three-year window from 2002 to 2004. The observations of the dependent variable *Access to LC* equal to one are firms signing new contracts from 2005 to 2007 (High and Low liquidity 1) or with unexpired contracts from 1995 to 2007 (High and Low liquidity 2). We also exercise robustness tests where firms in high and low liquidity 2 are coded zero for *Access to LC*. Both results support a

[19]For the 227 firms, the mean, the 25^{th} percentile, the median, the 75^{th} percentile of internal liquidity as a ratio of non-cash assets is 1,417.4%, -738.2%, -219%, 3.5% separately. For firms with non-cash assets larger than $ 1 million, the mean, the 25^{th} percentile, the median, the 75^{th} percentile of internal liquidity is 50%, 13.7%, 24.8%, and 51.2% separately.

consistent relationship between internal liquidity and access to the credit line. The regression results are reported in Table III.

[Insert Table III about here]

The coefficients for the internal liquidity are negative and significant in all four columns (Table III, Panel A). In general, the firms that apply for lines of credit and that banks have accepted their applications are indeed short of internal liquidity. The results confirm a unifying explanation of credit line access substituting for internal liquidity (Myers and Majluf, 1984). Furthermore, the coefficients of the two control variables, non-cash assets, and market-to-book, have the same sign and significance as in Sufi (2009).

The coefficients on size further support the bank's decisions. After firms submitted their applications, banks reviewed firms' performance in the past three years, from 2002 to 2004. Banks selectively grant access to those applications with higher tangible assets because banks are more confident if a borrower has higher collateral (non-cash assets).

To further understand firms and banks' decisions, we break the internal liquidity into cash flows and cash holdings. The test results are reported in Panel B. The coefficients for cash flows are positive and significant, consistent with Sufi (2009). But we document additional evidence: the cash holdings are negative.

Recall the realized credit line contracts are joint decisions of firms and banks. The contrast coefficients suggest a substitution effect between two internal liquidity sources: cash holdings and cash flows from the firm side. In our analysis, cash holdings are the immediate internal resource to address cash flow shocks. From the bank side, its risk management is to make sure that borrowers make interest rate payments. Therefore, banks choose to do business with consistent cash flows but might be temporarily short of cash holdings. For these borrowers, banks are less worried about interest rate payments. Together, evidence supports that credit lines are for unexpected liquidity shortages rather than to address chronically low cash flows. If this is true, we should find different results when we separate sample firms according to their

internal liquidity.

First, we examine the credit line realization in high liquidity firms. In Table II, Panel A, firms in high liquidity 1 and 2 have lower internal liquidity than high liquidity 3. Regression test results confirm that these firms' internal liquidity is lower than firms without access to credit lines in the high liquidity subsample firms (Table IV, Panel A).

Furthermore, the results confirm that these firms are short of cash holdings but not cash flows (Panel B). Firms in the subgroup of high liquidity reveal new information in addition to those in full sample tests. On the firm side, firms that apply for credit line access are short of cash holdings but not cash flows. There is also new information from the bank side. When banks make decisions, a higher cash flow is not necessary for these firms. These applicants can generate cash flows similar to those generating sufficient cash flows and not applying for external credit. In other words, banks do not worry about cash flows from these applicants. As for collateral concern, the loan principal is safer if borrowers have higher tangible assets (significant coefficient for *Size*). Furthermore, a higher growth rate is a positive tick for approval decisions.

We further test the consistency of internal liquidity. We compare the internal liquidity for firms in group 1A (regular credit line borrowers) and firms in group 2 (credit line borrowers from 1995 to 2004 with unexpired contracts). Test results are reported in Panel C. The differential between firms in group 1B (occasional credit line borrowers) and group 2 is reported in Panel D. Both results confirm the previous finding (Table I). The cash holdings and cash flows of regular borrowers with new contracts in 2005-2007 are not that different from firms' internal liquidity that signed contracts before 2005 (Panel C). Similar results are documented for occasional borrowers with new contracts from 2005 to 2007 (Panel D).

[Insert Table IV about here]

Next, we turn our analysis to firms in the category below the internal liquidity reference. In the same logic as in Tables II and IV, all firms below the liquidity reference should apply

for lines of credit. Therefore, the main reason that many firms have no access history in this category must be outside of firms' decisions. In other words, banks reject their applications. Test results are reported in Table V.

Unlike firms in the above-median category, firms in the below-median category with access to lines of credit have higher internal liquidity (Table V, panel A). The difference is mainly because of banks' selection. If it were a firm's choice, a firm with lower internal liquidity should be more desperate for external liquidity. Breaking down the internal liquidity, we find that banks select to grant applicants with higher cash flow (positive and significant coefficients on *Cash flows*) and higher tangible assets (positive and significant coefficients on *Size*) (Panel B). The higher cash flows and larger size enhance banks' confidence that borrowers can service drawdown interest rates and make principal repayment. In sum, banks reject credit applications from firms with low cash flows and low assets in the below-median category.

Like their counterparts reporting above the internal liquidity reference, borrowers with access to credit lines have similar internal liquidity, either cash flows or cash holdings. This is consistent between the above- and the below-median group. The internal liquidity persistence lasts for more than 20 years, from 1995 to 2007 (Panel C and Panel D).

[Insert Table V about here]

Our low collateral filter reveals the first quantitative bar on which banks actively reject low collateral applicants. We next generate the second quantitative bar on which banks actively reject low cash flow applicants. To make consistent interest rate payments, any firm must have a healthy stream of operation income. Since the drawdown interest rate should be higher than the risk-free rate, we conjecture that 6% return on assets would be a ballpark number, under which banks likely reject applications. *Low cash flows* is a dummy variable equal to one (1) if the average return on assets (OIBDP/(AT-CHE)) in the window of three years from 2002 to 2004 is lower than 6% per annual, or zero otherwise. We test the relation between low cash flows and access to lines of credit. Results are reported in Table VI.

Table VI, Panel A (Panel B) reports the firms in the above (below) internal liquidity reference. The coefficients for *Low cash flows* are negative and significant for both categories. The results reveal straightforward evidence that banks' concerns on interest rate payments. Taken the results together with the cash flows in Tables IV, V, and VI, banks turn down applications whose cash flows are unlikely to service interest rate payments.

[Insert Table VI about here]

Up to now, we have examined sequential decisions on credit line realization by firms and banks. For the banks' concerns, we have tested the average cash flows and tangible assets. As suggested by the Brownian motion, firms may not be able to service interest rate payments because their asset returns are too volatile. To test this conjecture, we generate a variable *Cash flow volatility*, a standard deviation of a firm's ten-year annual cash flow from 1995 to 2004. To be included in the sample, we require that each firm have at least eight annual data points.

Because the cash flow volatility is the second-moment statistic, by nature, it is a bank's consideration after banks have made their first-moment decisions on cash flows and tangible assets. In other words, some firms that have already passed the cash flow rejection bar will be rejected because their cash flow volatility is too high. In the line of reasoning, we test firms above the liquidity reference only. Four hundred thirty-seven firms drop out of the sample because they do not have at least eight-year data points. The results are reported in Table VII.

The coefficients for *Cash flow volatility* are negative and significant in Panels A and B. It confirms our conjecture that banks turn down applications with high cash flow volatility even if firms' cash flows have passed the first-moment screening. The coefficients for *Internal liquidity* are negative and significant in Panel A, confirming that firms are applying for credit lines because they are short of internal liquidity. The negative and significant coefficients for *Cash holdings* and insignificant coefficients for *Cash flows* confirm that these borrowers are short of cash holdings but not cash flows.

[Insert Table VII about here]

To sum up, we could explain that some firms have access to credit lines whereas others do not. There are two reasons that firms have no record of access to lines of credit. Some firms have sufficient internal liquidity, so they do not need to apply for credit lines in the first place. Firms that are short of internal liquidity apply for credit lines, but banks accept some applications while rejecting others. Banks likely reject applicants with lower assets, lower cash flows, or higher cash flow volatility. Our results consolidate the findings in Sufi (2009) and Campello et al. (2011). Yet, our analysis and empirical results have two additional findings. Firms do not apply for credit lines because they have sufficient internal liquidity. Banks reject applications to manage the drawdown risk. Because banks reject contract applications because of the concerns on drawdown risk, we analyze the realized drawdown activities during the crisis period in the next section.

6 Drawdowns of Regular Borrowers, the Demand Side Story

As we discussed in previous sections, the contract establishment of credit lines is a convergent decision between a borrower and a bank. Firms make the first move. Some apply for lines of credit, whereas others do not need to borrow. Of the firms in the former group, banks grant access to some, yet deny access to the rest. Because of the contract obligations, banks must honor drawdown requests from those with contracts and paying commitment fees. Therefore, we examine a demand-side story through drawdown decisions.

6.1 The 10-K survey in crisis, questionnaire design

Because the drawdown information is not available in DealScan, we collect from the company's 10-K. Because the 655 firms have been regular borrowers that have signed 95% of new credit line contracts from 2005 to 2007, we survey 10-Ks for the 655 firms in 2008 and 2009. In short, we are interested in the drawdowns of regular borrowers (with access to credit lines) in 2008 and 2009.

Although both studies analyze drawdowns, our research agenda is different from that of Ivashina and Scharfstein (2010). The authors have analyzed the bankruptcy shocks on drawdown externality. When a lender (Lehman Brothers) becomes insolvent, the co-syndicated banks of the same credit line contract will face heavier drawdown requests. Due to the restriction on the co-syndicated credit line contracts with Lehman, only 6% of the credit lines are analyzed in Ivashina and Scharfstein (2010).

We explore the drawdown behaviors of a different group of borrowers to answer a different question. We focus on regular borrowers that have signed 95% of the new credit line contracts in the three years from 2005 to 2007. We first document how much they drew in 2008 and 2009. With the drawdown variations, we answer the following question. Are drawdowns able to neutralize their liquidity shortages? The results can confirm or reject the demand side story.

Our survey collects both soft and hard information. The two hard information pieces are the total credit line outstanding and the drawdown amount. The soft information includes a firm's 10-K narrative about the firm's view on its liquidity situation, access to external credit, and what they have done if the external credit has been shocked. The goal of collecting soft information is to interpret the hard information correctly. For example, the hard information can tell us that the drawdown amount during the crisis period is low. We hope that a borrower may disclose which side is responsible for the drawdown. Is this because banks could not honor the drawdown requests or because firms have sufficient liquidity already?

Our survey method is similar to the methods adopted in the literature (Lins, Servaes, and Tufano, 2010; Campello, Giambona, Graham, and Harvey, 2011). We ask questions about corporate liquidity management and companies' views about market liquidity during the crisis period. The uniqueness of our survey is the interviewees. Unlike the CFOs who the previous studies have interviewed, we ask questions and collect responses from a company's 10-K. More specifically, we read the Liquidity and Capital Resources section under Item 7 on Management's Discussion and Analysis of Financial Condition and Results of Operations. The same source has been used in Kaplan and Zingales (1997), Sufi (2009), Bodnaruk, Loughran,

and McDonald (2015), and Hoberg and Maksimovic (2015). We trust the information collected from 10-K for two reasons. By law, regulators (SEC) prohibit companies from providing misleading or materially false information in 10-Ks. Furthermore, since the Sarbanes-Oxley Act of 2002, a company's CEO and CFO must certify the accuracy of the information provided in the company's 10-K. In summary, the survey results based on 10-K statements should be free of concerns about litigation risk. After reading the relevant section in 10-K, we ask six questions and collect responses, if any.

[1] What are the top sources of liquidity for your company?

[2] How did you describe the company's overall liquidity condition in 2008/2009?

[3] Did you find it difficult to access external credit markets in 2008/2009?

[4] Did the supply side or the demand side negatively affect your business more?

[5] Did your company have a specific relationship bank(s) that was(were) in trouble? If so, did the company try to find a replacement?

[6] What is your company's total credit line? How much did your company draw down?

Because 10-K has been certified, we treat the answers collected from 10-Ks as legal answers from the firm's CEO or CFO. The questionnaire is reported in Appendix A. We include the sample answers we have coded for the question.

[Insert Appendix A about here]

6.2 Qualitative and quantitative responses, regular borrowers

We read the 10-K sections, identify the answers, and coded answers to each question if 10-K has provided an answer. Five of the six questions target all regular borrowers. Question five is for firms with one or more relationship banks being shocked, such as Lehman Brothers.

We expect only the firms with connections to bank(s) being shocked may offer their views on question five. Furthermore, because we design the questions after firms file their 10-Ks, it is not a surprise that not every 10-K answers all questions. If they don't answer, we don't speculate the official view on the unanswered question(s). The following is a summary of the answers.

Eight hundred and thirty-five firm-year 10-Ks have answered the first question. The top three sources of liquidity in decreasing order are internal liquidity (including cash holdings and cash flows), credit lines, and commercial paper. The results are reported in Table VIII. Recall that 655 firms are regular users that signed 95% new contracts in dollar amount from 2005 to 2007. However, internal liquidity is ranked as the number one source of liquidity for these regular borrowers with access to credit lines. Credit lines are the number two liquidity source, but the number one among external liquidity sources.

[Insert Table VIII about here]

Do companies have sufficient total liquidity? Seven hundred and seventy-eight firm-year 10-Ks have answered the second question. Among the 792 responses, 799 firm-year 10-Ks describe that their companies had adequate liquidity overall in 2008 and 2009. Only 3 firm-year 10-Ks note that overall liquidity was constrained.

The answers to questions 1 and 2 do not support that these regular borrowers of credit lines were short of liquidity in the two-year crisis period. Because this question is about total liquidity, sufficient total liquidity could come from two different sources: internal or external. We will shortly further test internal liquidity and drawdowns in regression analysis.

Did companies find it difficult to access external credit markets in 2008/2009? 224 firm-year 10-Ks have discussed access to external liquidity. 213 firm-year responses identify that their firms had no difficulty accessing external liquidity in 2008-2009. Only 11 firm-year 10-Ks mention the problem.

Did the supply side or the demand side negatively affect the company's business more? 104 10-Ks have discussed their views on the supply-side shock or demand-side shock. 101

firm-year 10-Ks mention the demand-side shock. 3 firm-year 10-Ks mention the supply-side shock.

Did your company have a specific relationship bank(s) that was(were) in trouble? If so, did the company try to find a replacement? 35 firm-year 10-Ks claimed that one of their banks had some issues. However, none of the 10-Ks mentioned bank changes.

844 firm-year 10-Ks answer to question six: the outstanding credit lines and the drawdown amounts. 839 firm-year responses give us information on both the total lines of credit outstanding and the drawdown amount. On average, regular borrowers drew down 25% of their total credit lines in 208 and 2009.

The qualitative information reveals three pieces of information. First, even for regular credit line users, internal liquidity is still their number one liquidity source. Second, these firms have sufficient liquidity during the crisis period and have no problem accessing external liquidity if they wish. Third, the companies in our sample are different from those in Ivashina and Scharfstein (2010). Lehman's bankruptcy filing had a limited impact on the regular borrowers in 2008 and 2009.

Up to now, we have analyzed the demand side story from two fronts. If we agree that financial contracts should be a balance between supply and demand, drawdowns are solo decisions of the borrowers. From the soft and hard information collected from regular borrowers, companies do not seem to experience liquidity shortages. They only drew a small proportion of their outstanding lines, and their official narratives did not complain about liquidity shortages. One concern is that the Management Discussion in Item 7 could be rhetorical on the bright side. However, real liquidity shortages could be much more serious. To rule out rhetorical concerns, we turn to regression analysis to see whether drawdowns can neutralize liquidity shortages during the crisis period. For example, if for some reason supply constraints did play significant roles in driving the 25% drawdowns, these regular borrowers must display short of total liquidity, equal to the sum of internal liquidity and drawdowns. This is what we will test in Section 6.3.

6.3 Can drawdowns neutralize internal liquidity shortages?

Because firms with regular credit line access are in the 7^{th} to 10^{th}decile, we only include firms without credit line access records in the same four size deciles. For firms with regular usage of lines of credit, we create two total liquidity measures. *Total liquidity I* is a sum of internal liquidity and drawdown credit lines. *Total liquidity II* is a sum of internal liquidity and the total credit lines, which include undrawn lines of credit. Both drawdown and total outstanding are from firms' 10-Ks.

Before running the regressions, we plot the equal-weighted liquidity in 2008 and 2009 in Figure IV. The internal liquidity for regular CL borrowers (in group 1A) is a blue dashed line, coded as *Regular borrowers, drawdown=0* (Internal liquidity/(AT-CHE)). The *Total liquidity I*, the sum of internal liquidity and drawdown ((Internal liquidity + CL drawdown)/(AT-CHE)), is an orange dotted line, coded as *Regular borrowers with CL drawdown*. The *Total liquidity II*, the sum of internal liquidity and total credit lines ((Internal liquidity + total CL)/(AT-CHE)), is a green dotted line, coded as *Regular borrowers with total CL*. The internal liquidity for firms without a history of credit line (in group 3) is a solid crimson line, coded as *Firms without CL*.

[Insert Figure IV about here]

Panel A is for all regular borrowers and their industry peers in the same size deciles from decile 7 to decile 10. Panel B and Panel C have separated the firms into above or below internal liquidity reference. There are three observations. First, the regular borrowers' internal liquidity is lower than that of their peers without a history of credit line access. Second, regular borrowers only draw a part of their credit lines. Third, larger firms (in decile 10) draw a lower amount relative to their size than smaller firms (in decile 7).

Next, we turn to regression analysis to further understand the above observations. As in the previous tables, regressions are conducted for firms above and below the liquidity reference, separately. There are three independent variables *Size*, *Market-to-book*, and *Access to LC*. *Access*

to LC is a dummy variable equal to one if a firm is identified as a regular credit line borrower in 2005-2007 (in group 1A) or zero otherwise (in group 3). The two dependent variables are (Total liquidity I) and (Total liquidity II). For firms without records of credit line access, the total credit lines and the drawdown credit lines will be zero. The dependent variables are the average of 2008 and 2009. The firm classification of above and below industry peers uses the data in 2005-2007. We report test results for firms above the internal liquidity reference in Table IX. The results for firms below the internal liquidity reference are reported in Table X.

[Insert Table IX and X about here]

We discuss each coefficient for firms above or below the internal liquidity reference. In univariate specifications, the coefficient for *Access to CL* is negative and significantly related to *Total liquidity I* for firms above liquidity reference (Table IX Panel A, column 1). Still, the coefficient keeps positive for firms below the liquidity reference (Table X Panel A, column 1). But after controlling for firm size, market-to-book, and industry effect, both coefficients become insignificant (Table IX and Table X Panel A, column 4). The regression results confirm that the drawdowns helped to satisfy internal liquidity shortages between the total liquidity of regular borrowers and the internal liquidity of firms without access to the credit line. In other words, 25% drawdowns are voluntary, not restricted by lending banks.

Although it is not a supply-side story by the contract obligations, we tempt to explain the empirical findings in this section from the supply-side story to serve as counterfactual arguments. If lending banks were functional, but had restricted drawdown requests due to bank problems, borrowers from the below reference liquidity subgroup would have drawn down less (Table X, Panel A, column 4). However, the coefficients for *Access to CL* for firms below the liquidity reference are not significant.

Firm size is a proxy for collateral, and banks are more likely to grant access to larger borrowers in the contracting stage. Now, companies make their drawdown decisions. If there had been bank problems to restrict drawdowns, banks would have restricted the drawdowns of

firms with lower collateral (smaller borrowers). This explanation is consistent with the positive and significant coefficients for size control for firms below the liquidity reference (Table X, panels A and B, column 4). However, the supply side story cannot simultaneously explain the drawdowns of borrowers above the liquidity reference. *Size*'s coefficients become negative and significant (Table IX, Panel A, columns 2 to 4). Putting firms below or above the internal liquidity reference in perspective, only the demand side story can simultaneously explain the size effect of drawdown decisions of regular borrowers.

The results are similar for the coefficients of *Market-to-book*. When companies in the subgroup below the internal liquidity reference sign new contracts, *Market-to-book* coefficients are positive and significant (Table III, Panel B, column 4; Table V, Panel B, column 4). In the contract establishment stage, the supply side story that banks prefer to grant access to firms with greater growth potential is natural. In the drawdown stage, as we argue from lender obligations, regular borrowers have complete control of drawdown decisions. However, if there were bank problems to restrict drawdowns, banks would start from firms with lower market-to-book because the principal repayment risk is higher. In other words, coefficients should be positive and significant for regular borrowers below the internal liquidity reference. However, we observe negative and significant coefficients for *Market-to-Book* for borrowers below the liquidity reference (Table X, Panel A and B, column 4). Again, only the demand-side story can explain the coefficients for *Market-to-Book* for all regular borrowers, above or below the internal liquidity reference.

The test results also confirm that the total liquidity II is higher than that of firms without access to lines of credit. The coefficients for *Access to CL* are positive and significant (Table IX Panel B and Table X Panel B column 4). This observation is consistent for firms above and below the liquidity reference. The comprehensive information that we have collected supports the demand-side story.

To further address the concern that bank problems cause fractional drawdowns, we carry out one more test. We compare the drawdown ratio of regular borrowers only. The depen-

dent variable, *Drawdown LC*, is the CL drawdown scaled by noncash assets (*Drawdown LC/(ATCHE)*). For each regular borrower, the drawdown is an average of 2008 and 2009. The main independent variable is a dummy variable, *Above liquidity reference*, which is equal to one if a regular borrower is in the subgroup above the internal liquidity reference or zero otherwise. The (*Above liquidity reference*) is based on credit line access from 2005 to 2007, so are two independent variables of (*Size*) and (*Market-to-book*). The results are reported in Table XI.

[Insert Table XI about here]

Recall that the internal liquidity for regular borrowers is 30% (median) and 42% (mean) above the internal liquidity reference vs. 15% (median) and 15% (mean) below the liquidity reference before the crisis. If it were bank problems to restrict drawdown requests, the impact on borrowers below the liquidity reference would be more severe. Therefore, we expect a positive correlation between *Drawdown CL* and *Above industry median* if it were a supply-side story. However, the coefficients are negative and significant (Table XI, columns 1 to 4). In other words, banks honor the drawdown requests more from borrowers that have lower internal liquidity prior to the crisis. Therefore, there is no reason banks did not honor requests from borrowers with higher internal liquidity if the latter have drawdown requests. The only answer left here is that these firms don't need to draw down that much. This is a demand-side story.

7 Conclusion

We propose three assumptions to model a fair liquidity contract between demand and supply. On the liquidity demand side, we assume stochastic operating income. On the liquidity supply side, we assume active banks, and they will choose between granting access or rejecting applications. The third assumption is necessary to allow each side of the demand and supply pair to maximize its own utility.

We have solved convergent decisions from the liquidity demand and supply sides through

extensive-form games. Our model has three predictions. First, companies must prioritize the liquidity needs of existing operations over new investment projects. Second, our model predicts the distribution of credit line contracts. The prediction has identified two reasons why a company has no access to credit lines. A company that is rich in internal liquidity will not apply for credit lines. On the other end of the internal liquidity spectrum, companies in the bottom tercile internal liquidity are desperate to access credit lines. However, banks will reject their applications simply because they have a poor operating record generating cash flows that are critical to meeting debt payment obligations. Our model also predicts the conditions of access to term loans or convertible debt.

For identification purposes, we analyze the access to credit lines of Compustat firms from 2002 to 2009. We have two findings on the realized distribution of credit line access during normal times, one on each side of the borrowers and banks. The pecking order theory plays an important role on the borrower side. Some firms have sufficient internal liquidity. Therefore, these firms won't apply for external liquidity in the first place. Among firms that are short of internal liquidity, most of them will apply for it. However, now it is up to banks' decision. Banks will reject the application at least for two reasons. Intuitively, banks reject applications that borrowers may have difficulty servicing interest rate payments or principal repayment.

We have also documented a demand-side story of how borrowers draw down credit lines during the 2008 crisis period. The regular borrowers claim that they have sufficient internal liquidity and have no problems accessing external liquidity. When their relationship banks could not fulfill the commitment, they did not seek replacements. In addition to the supply-side shock, we also document, perhaps the first time, a large-scale borrowing reduction from the borrower side. Larger regular borrowers draw down less than smaller regular borrowers when their internal liquidity was above the liquidity reference. Furthermore, regular borrowers with high internal liquidity draw down less than regular borrowers with low internal liquidity.

References

Acharya, V. V., H. Almeida, and M. Campello (2013). Aggregate risk and the choice between cash and lines of credit. *Journal of Finance 68*(5), 2059–2116.

Acharya, V. V., L. H. Pedersen, T. Philippon, and M. Richardson (2017). Measuring systemic risk. *Review of Financial Studies 30*(1), 2–47.

Almeida, H., M. Campello, I. Cunha, and M. S. Weisbach (2014). Corporate liquidity management: A conceptual framework and survey. *Annual Review of Financial Economics 6*(1), 135–162.

Almeida, H., M. Campello, and M. S. Weisbach (2004). The cash flow sensitivity of cash. *Journal of Finance 59*(4), 1777–1804.

Ashcraft, A. B. (2005). Are banks really special? new evidence from the fdic-induced failure of healthy banks. *American Economic Review 95*(5), 1712–1730.

Bae, K.-H., J.-K. Kang, and C.-W. Lim (2002). The value of durable bank relationships: evidence from korean banking shocks. *Journal of Financial Economics 64*(2), 181–214.

Bates, T. W., K. M. Kahle, and R. M. Stulz (2009). Why do us firms hold so much more cash than they used to? *Journal of Finance 64*(5), 1985–2021.

Berg, T., A. Saunders, and S. Steffen (2016). The total cost of corporate borrowing in the loan market: Don't ignore the fees. *Journal of Finance 71*(3), 1357–1392.

Berger, A. N. and C. H. S. Bouwman (2009, 01). Bank Liquidity Creation. *Review of Financial Studies 22*(9), 3779–3837.

Berk, J. and P. DeMarzo (2017). Corporate finance, 4th edition, global ed. *Essex: Person Education Limited*.

Bodnaruk, A., T. Loughran, and B. McDonald (2015). Using 10-k text to gauge financial constraints. *Journal of Financial and Quantitative Analysis*, 623–646.

Boot, A., A. V. Thakor, and G. F. Udell (1987). Competition, risk neutrality and loan commitments. *Journal of Banking & Finance 11*(3), 449–471.

Calomiris, C. W. and J. R. Mason (2003). Consequences of bank distress during the great depression. *American Economic Review 93*(3), 937–947.

Campello, M. (2002). Internal capital markets in financial conglomerates: Evidence from small bank responses to monetary policy. *Journal of Finance 57*(6), 2773–2805.

Campello, M., E. Giambona, J. R. Graham, and C. R. Harvey (2011). Liquidity management and corporate investment during a financial crisis. *Review of Financial Studies 24*(6), 1944–1979.

Chava, S. and A. Purnanandam (2011). The effect of banking crisis on bank-dependent borrowers. *Journal of Financial Economics 99*(1), 116–135.

Chu, J. (2023). Bank asset problem and financial stability. *Working paper*.

Chu, J. and J. Ou (2022). Household delinquency, bank capital buffer, and risk-taking spillover. *Working paper*.

Denis, D. J. and S. B. McKeon (2020). Persistent negative cash flows, staged financing, and the stockpiling of cash balances. *Journal of Financial Economics forthcoming*.

Diamond, D. W. (1984, jul). Financial Intermediation and Delegated Monitoring. *The Review of Economic Studies 51*(3), 393.

Diamond, D. W. and P. H. Dybvig (1983). Bank runs, deposit insurance, and liquidity. *Journal of political economy 91*(3), 401–419.

Diamond, D. W. and R. G. Rajan (2005). Liquidity shortages and banking crises. *Journal of Finance 60*(2), 615–647.

Garcia-Appendini, E. and J. Montoriol-Garriga (2013). Firms as liquidity providers: Evidence from the 2007–2008 financial crisis. *Journal of Financial Economics 109*(1), 272–291.

Gatev, E. and P. E. Strahan (2006). Banks' advantage in hedging liquidity risk: Theory and evidence from the commercial paper market. *Journal of Finance 61*(2), 867–892.

Gertler, M. and S. Gilchrist (1994). Monetary policy, business cycles, and the behavior of small manufacturing firms. *Quarterly Journal of Economics 109*(2), 309–340.

Gibson, M. S. (1995). Can bank health affect investment? evidence from japan. *Journal of Business*, 281–308.

Hoberg, G. and V. Maksimovic (2015). Redefining financial constraints: A text-based analysis. *Review of Financial Studies 28*(5), 1312–1352.

Holmström, B. and J. Tirole (1998). Private and public supply of liquidity. *Journal of Political Economy 106*(1), 1–40.

Holmström, B. and J. Tirole (2011). *Inside and Outside Liquidity*. The MIT Press.

Ivashina, V. and D. Scharfstein (2010). Bank lending during the financial crisis of 2008. *Journal of Financial Economics 97*(3), 319–338.

Kahle, K. M. and R. M. Stulz (2013). Access to capital, investment, and the financial crisis. *Journal of Financial Economics 110*(2), 280–299.

Kang, J.-K. and R. M. Stulz (2000). Do banking shocks affect borrowing firm performance? an analysis of the japanese experience. *Journal of Business 73*(1), 1–23.

Kaplan, S. N. and L. Zingales (1997). Do investment-cash flow sensitivities provide useful measures of financing constraints? *Quarterly Journal of Economics 112*(1), 169–215.

Kashyap, A. K., O. A. Lamont, and J. C. Stein (1994). Credit conditions and the cyclical behavior of inventories. *Quarterly Journal of Economics 109*(3), 565–592.

Kashyap, A. K., R. Rajan, and J. C. Stein (2002). Banks as liquidity providers: An explanation for the coexistence of lending and deposit-taking. *Journal of finance 57*(1), 33–73.

Kashyap, A. K., J. C. Stein, and D. W. Wilcox (1993). Monetary policy and credit conditions: Evidence from the composition of external finance. *American Economic Review 83*(1), 78–98.

Keynes, J. M. (1936). The general theory of employment, interest and money. *Palgrave Macmillan*.

Khwaja, A. I. and A. Mian (2008). Tracing the impact of bank liquidity shocks: Evidence from an emerging market. *American Economic Review 98*(4), 1413–42.

Leary, M. T. (2009). Bank loan supply, lender choice, and corporate capital structure. *Journal of Finance 64*(3), 1143–1185.

Lins, K. V., H. Servaes, and P. Tufano (2010). What drives corporate liquidity? an international survey of cash holdings and lines of credit. *Journal of Financial Economics 98*(1), 160–176.

Merton, R. C. (1974). On the pricing of corporate debt: The risk structure of interest rates. *Journal of Finance 29*(2), 449–470.

Myers, S. C. and N. S. Majluf (1984). Corporate financing and investment decisions when firms have information that investors do not have. *Journal of Financial Economics 13*(2), 187–221.

Nikolov, B., L. Schmid, and R. Steri (2019). Dynamic corporate liquidity. *Journal of Financial Economics 132*(1), 76–102.

Paravisini, D. (2008). Local bank financial constraints and firm access to external finance. *Journal of Finance 63*(5), 2161–2193.

Peek, J. and E. S. Rosengren (2000). Collateral damage: Effects of the japanese bank crisis on real activity in the united states. *American Economic Review 90*(1), 30–45.

Puri, M., J. Rocholl, and S. Steffen (2011). Global retail lending in the aftermath of the us financial crisis: Distinguishing between supply and demand effects. *Journal of Financial Economics 100*(3), 556–578.

Schnabl, P. (2012). The international transmission of bank liquidity shocks: Evidence from an emerging market. *Journal of Finance 67*(3), 897–932.

Shleifer, A. and R. W. Vishny (1992). Liquidation values and debt capacity: A market equilibrium approach. *Journal of Finance 47*(4), 1343–1366.

Strebulaev, I. A. and B. Yang (2013, jul). The mystery of zero-leverage firms. *Journal of Financial Economics 109*(1), 1–23.

Sufi, A. (2009). Bank lines of credit in corporate finance: An empirical analysis. *Review of Financial Studies 22*(3), 1057–1088.

Thakor, A., H. Hong, and S. I. Greenbaum (1981). Bank loan commitments and interest rate volatility. *Journal of Banking & Finance 5*(4), 497–510.

Thakor, A. V. (1982). Toward a theory of bank loan commitments. *Journal of Banking & Finance 6*(1), 55–83.

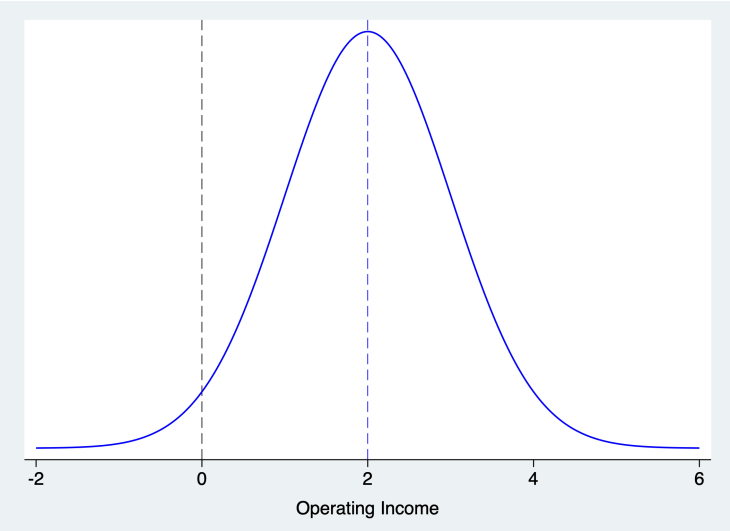
Whalen, E. L. (1966). A rationalization of the precautionary demand for cash. *The Quarterly Journal of Economics 80*(2), 314–324.

Figures

Figure I. Company's $EBIT$ distribution

Figure I illustrate the distribution of $EBIT_{i,t}$ of two types of firms. The distribution is normal with $\sigma = 1$. The mark 0 indicates breakeven $EBIT$, with positive (negative) numbers for positive (negative) $EBIT$. For companies of Type I (Fig. A), mark 0 equal to $\mu - 1.96 \times \sigma$. In 97.5% of the periods, Type I firms report positive $EBIT_t$. For companies of Type IIB (Fig. B), mark 0 equal to $\mu + 0.67 \times \sigma = 0$. In 75% of the periods, Type IIB firms report negative $EBIT_t$.

(A) Type I



(B) Type IIB

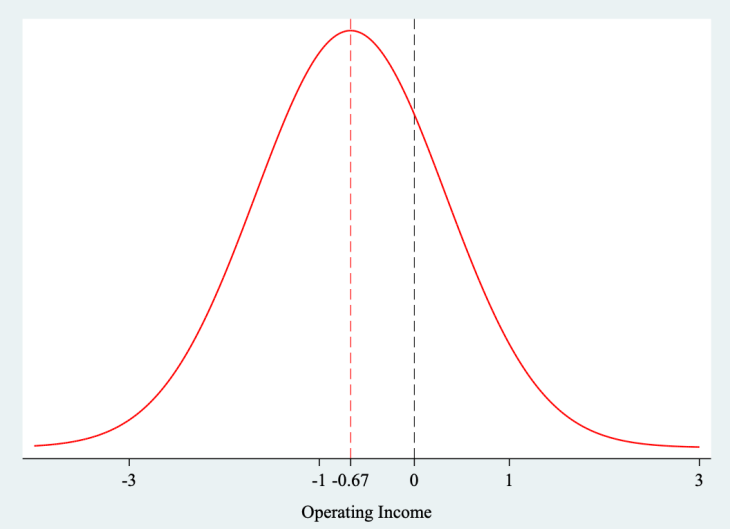
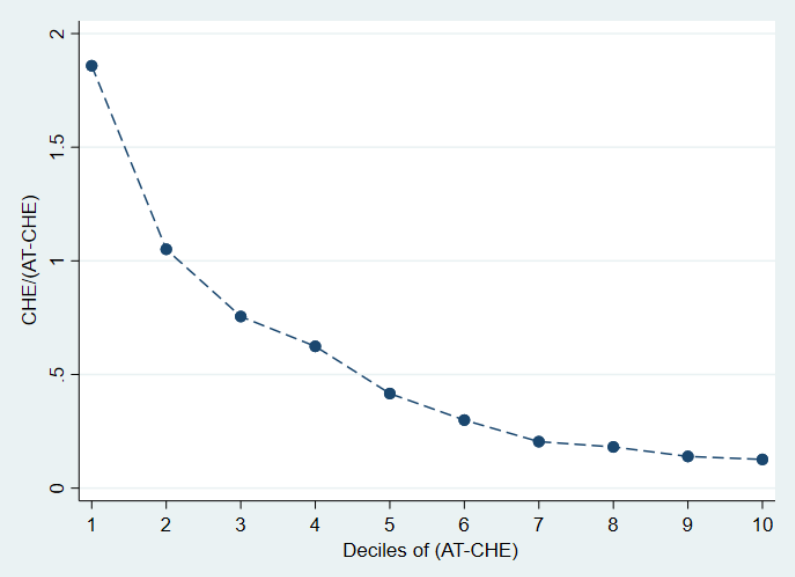


Figure II. Cash flow ratio and cash holding ratio in size decile

Figure I plot cash holdings and cash flows as a percentage of the firm's non-cash total assets. There are 3,469 non-financial, non-utility firms in North America. Cash holding ratio is *(CHE/(AT-CHE))*. Cash flow ratio is *(OIBDP/(AT-CHE))*. Size is *(AT-CHE)*. The size decile is average of 2005-2007. The cash and cash flow ratios are in the fiscal year 2008 and 2009 data, which are winsorized at 2.5% on each side.

(A) Equal-weighted cash ratio



(B) Equal-weighted cash flow ratio

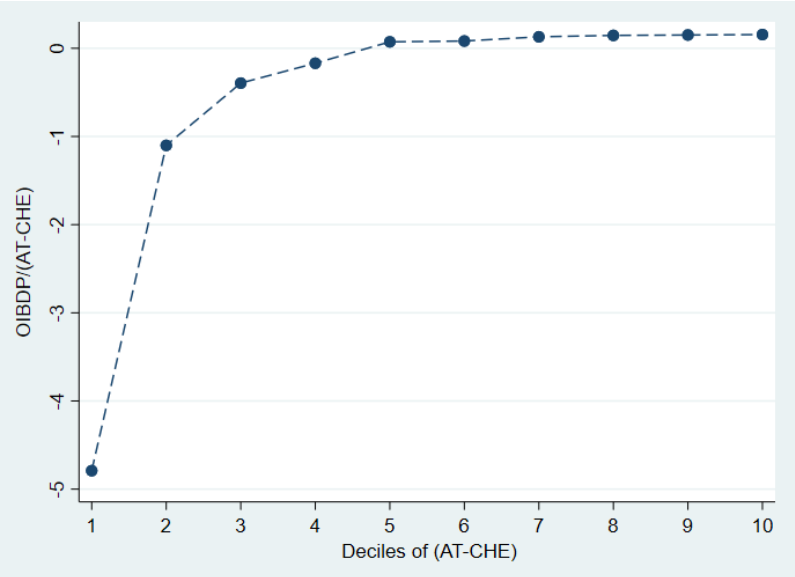


Figure III. The internal liquidity and access to lines of credit.

We identify 655 regular borrowers on lines of credit (Regular borrowers, new CL, group 1A) and 599 occasional borrowers on lines of credit (Occasional borrowers, new CL, group 1B), based on the dollar amount new contracts of lines of credit reported in DealScan in 2005-2007. The 1,254 borrowers are in North America, with GVKEY in non-financial, non-utility industries. The 655 regular borrowers account for 95% of the dollar amount on credit line contracts from 2005 to 2007. The occasional borrowers account for the rest 5% of the contract dollar amount. Firms that have unexpired credit line contracts signed in the period of 1995-2004 but without signing new credit line contracts in 2005-2007 are in group 2 (Borrowers with unexpired CL but no new CL). The rest firms without access to credit lines from 1995 to 2007 are in group 3. The internal liquidity ratio is *(CHE + OIBDP)/(AT-CHE)*. For each firm, we calculate and plot the average internal liquidity ratio in the two years of 2008-2009. The size deciles are based on Compustat data from 2002 to 2004.

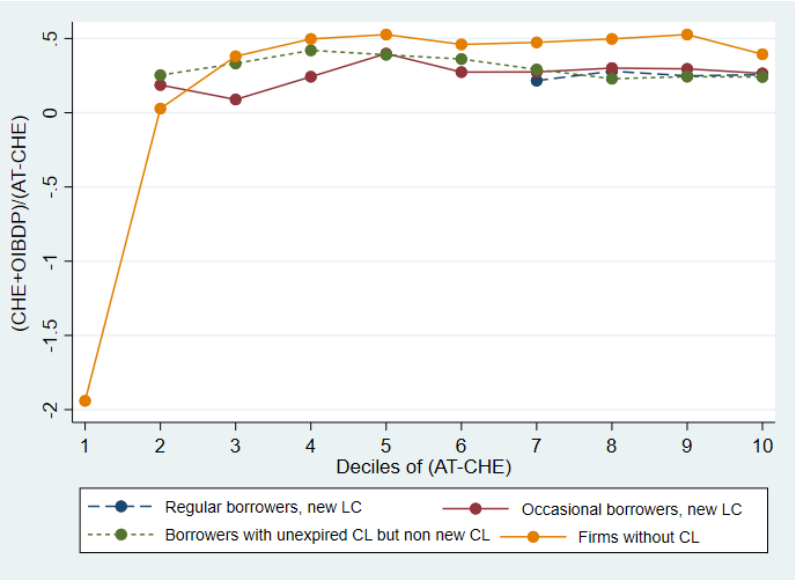
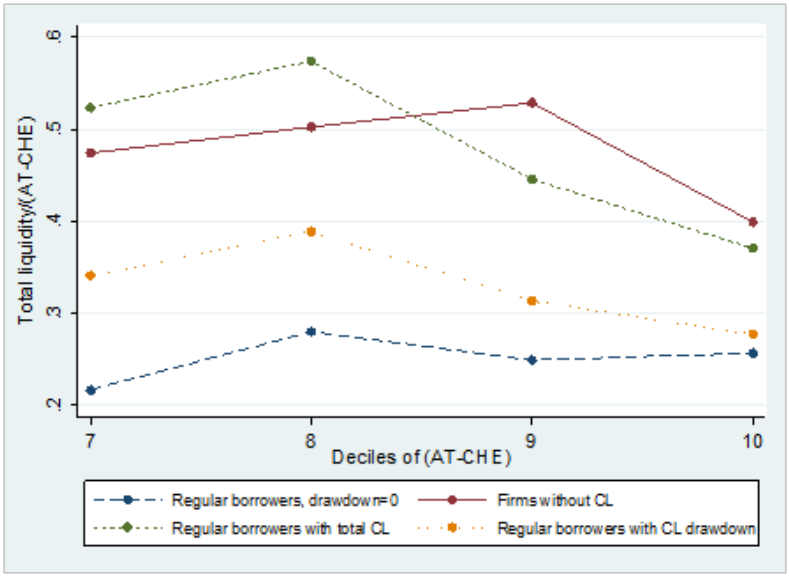


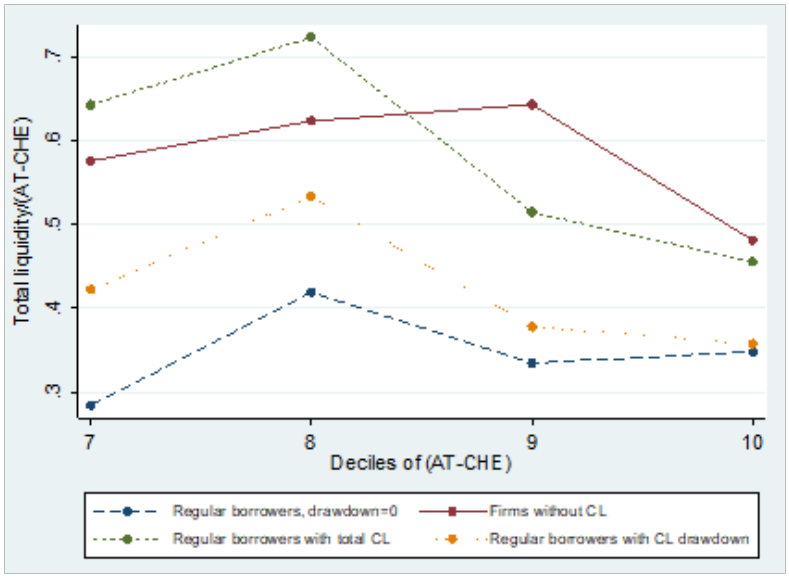
Figure IV. Drawdown and total CL of regular borrowers in 2008-2009

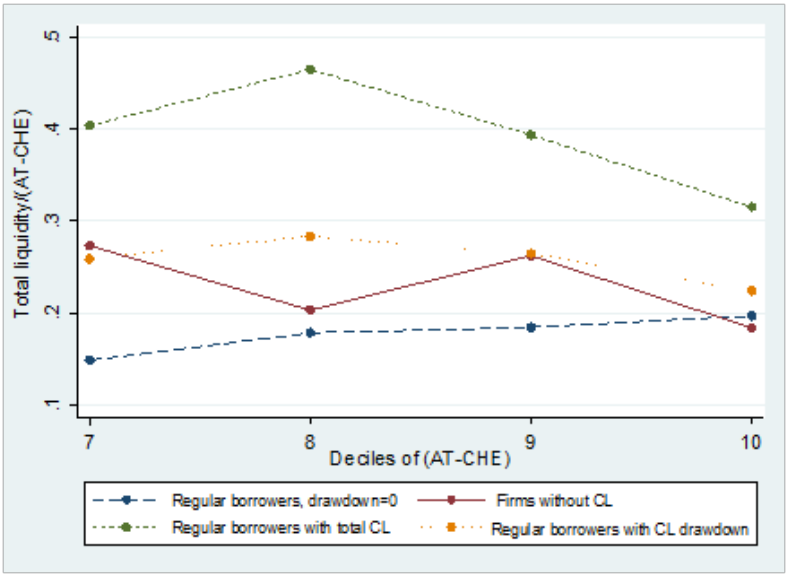
This figure plots regular credit line borrowers (group 1A) and firms without access to credit lines in size decile 7 to decile 10. The firm and firm size identification follow that in Figure II. The total liquidity is the sum of cash holdings (CHE), cash flows (OIBDP) and lines of credit. Each plot includes four equal-weighted average of liquidity measurements. The bottom blue cashed line is the internal liquidity *(CHE + OIBDP)/(AT - CHE)* of regular borrowers of lines of credit (Regular borrowers, drawdown=0). The solid crimson line is the internal liquidity *(CHE + OIBDP)/(AT - CHE)* of firms without credit lines (Firms without CL). The orange dotted line is the total liquidity I *(CHE + OIBDP + CL drawdown)/(AT - CHE)* for regular borrowers of lines of credit (Regular borrowers with CL drawdown). The top green dotted line is the total liquidity II *(CHE + OIBDP + total CL)/(AT - CHE)* for regular credit line borrowers (Regular borrowers with total CL).

(A) All firms



(B) Firms with internal liquidity above the internal liquidity reference





(C) Firms with internal liquidity below the liquidity reference

Tables

Table I. With or without credit line access and internal liquidity, full sample

This table provides the summary statistics of the sample. Our sample starts from 3,469 North American non-finance, non-utility firms in Compustat with no missing data on assets (AT), long-term debt (DLTT), short-term date (DLC), cash flows (OIBDP) and cash holdings (CHE) in all three years from 2005 to 2007. *Internal liquidity =(CHE+OIBDP)/(AT–CHE); Cash holdings =CHE/(AT–CHE); Cash flows=OIBDP/(AT–CHE); No cash assets=AT–CHE*. Using the data in 2002-2004, we allocate sample firms (sample number drops to 3,463) into ten size deciles and two subgroups. Size is based on no cash assets. Suppose a firm's average internal liquidity in 2002-2004 is higher (lower) than its internal liquidity reference in the same period. In that case, this firm is in the subgroup of above (below) the internal liquidity reference. We follow the Fama-French 12-industry classification. We map 655 regular borrowers and 599 occasional borrowers of lines of credit to 3,463 sample firms. 458 regular borrowers (Regular borrowers, new CL) and 417 occasional borrowers (Occasional borrowers, new CL) are left in the sample. The rest 2,588 firms have no new credit line contract in 2005-2007, but 641 firms have unexpired credit line contracts signed between 1995 and 2004. Panel A reports the number of unique firms with access to credit lines, either historical contracts signed between 1995 and 2004 or new contracts signed between 2005 and 2007. Panel B reports total outstanding credit lines ($ billions) in all contracts that a firm has signed but has not matured yet. Panel C presents the credit line ratio = CL/(AT-CHE).

Panel A. Number of distinct firms

	Number of firms				
	2005	2006	2007	2008	2009
Regular borrowers, new CL	443	451	456	457	457
Occasional borrowers, new CL	327	375	415	401	377
Borrowers with unexpired CL but no new CL	553	521	520	578	608

Panel B. Unexpired credit line contracts in dollar amount ($ billions)

	Total unexpired credit line contracts				
	2005	2006	2007	2008	2009
Regular borrowers, new CL	772	941	1,140	1,140	1,080
Occasional borrowers, new CL	69.7	74.5	76.5	80.4	79.4
Borrowers with unexpired CL but no new CL	471	533	610	615	576

Panel C. Credit line as a ratio of non-cash assets

	LC/(AT-CHE)				
	2005	2006	2007	2008	2009
Regular borrowers, new CL	0.511	0.605	0.726	0.719	0.701
Occasional borrowers, new CL	0.532	0.587	0.621	0.668	0.682
Borrowers with unexpired CL but no new CL	0.403	0.479	0.538	0.59	0.581

Table II. Internal liquidity, liquidity reference, and access to lines of credit

Our sample starts from 3,469 North American non-finance, non-utility firms in Compustat with no missing data on assets (AT), long-term debt (DLTT), short-term date (DLC), cash flows (OIBDP), and cash holdings (CHE) in all three years from 2005 to 2007. *Cash holdings: CHE/(AT–CHE); Cash flows: OIBDP/(AT–CHE); Internal liquidity is the sum of cash holdings and cash flows, (CHE+OIBDP)/(AT–CHE); Non-cash assets: AT–CHE*. Using the data in 2002-2004, we allocate sample firms (sample number drops to 3,463) into two subgroups. Suppose a firm's average internal liquidity in 2002-2004 is higher (lower) than its internal liquidity reference in the same period. In that case, this firm is in the subgroup of above (below) the internal liquidity reference. We follow the Fama-French 12-industry classification.

Panel A. Above internal liquidity reference and access to lines of credit

	N	Mean	Std Dev	25th	Median	75th
High liquidity 1A: Regular borrowers, new CL contracts in 2005-2007						
Internal liquidity	222	0.434	0.431	0.24	0.301	0.413
Cash holdings	222	0.244	0.587	0.069	0.117	0.232
Cash flows	222	0.193	0.184	0.15	0.194	0.244
Non-cash assets	222	4600.428	6427.387	751.512	1915.219	4748.633
High liquidity 1B: Occasional borrowers, new CL contracts in 2005-2007						
Internal liquidity	217	0.589	0.61	0.267	0.398	0.635
Cash holdings	217	0.433	0.766	0.099	0.208	0.435
Cash flows	217	0.15	0.3	0.124	0.176	0.237
Non-cash assets	217	518.545	1633.541	94.339	218.18	531.468
High liquidity 2: Borrowers with unexpired CL signed in 1995-2004 but no new contracts in 2005-2007						
Internal liquidity	317	0.527	0.557	0.262	0.334	0.536
Cash holdings	317	0.364	0.827	0.082	0.157	0.329
Cash flows	317	0.143	0.548	0.137	0.192	0.248
Non-cash assets	317	3567.2	6611.423	122.47	408.848	2306.462
High liquidity 3: Firms without CL from 1995 to 2007						
Internal liquidity	1024	1.154	1.137	0.41	0.683	1.428
Cash holdings	1024	1.477	2.012	0.272	0.65	1.632
Cash flows	1024	-0.521	2.095	-0.224	0.104	0.221
Non-cash assets	1024	702.871	2939.887	8.69	33.776	143.794
High liquidity 3: Firms without CL from 1995 to 2007, Non-Cash Assets>=1						
Internal liquidity	979	1.07	1.022	0.4	0.659	1.312
Cash holdings	979	1.279	1.735	0.264	0.621	1.461
Cash flows	979	-0.294	1.508	-0.153	0.114	0.228
Non-cash assets	979	735.158	3002.811	10.942	38.102	154.585

Panel B. Below internal liquidity reference and access to lines of credit

	N	Mean	Std Dev	25th	Median	75th
Low liquidity 1A: Regular borrowers, new CL contracts in 2005-2007						
Internal liquidity	236	0.157	0.056	0.125	0.153	0.186
Cash holdings	236	0.041	0.04	0.016	0.029	0.051
Cash flows	236	0.117	0.05	0.093	0.118	0.147
Non-cash assets	236	5478.953	6766.525	1050.433	2101.807	7026.027
Low liquidity 1B: Occasional borrowers, new CL contracts in 2005-2007						
Internal liquidity	200	0.083	0.579	0.107	0.14	0.177
Cash holdings	200	0.064	0.116	0.015	0.03	0.076
Cash flows	200	-0.017	1.037	0.065	0.098	0.132
Non-cash assets	200	620.241	1799.558	98.318	252.289	601.33
Low liquidity 2: Borrowers with unexpired CL signed in 1995-2004 but no new contracts in 2005-2007						
Internal liquidity	324	0.133	0.193	0.108	0.149	0.188
Cash holdings	324	0.071	0.167	0.013	0.033	0.078
Cash flows	324	0.061	0.304	0.063	0.106	0.137
No cash assets	324	2475.778	5152.545	91.862	430.166	1903.977
Low liquidity 3: Firms without CL from 1995 to 2007						
Internal liquidity	923	-0.847	1.832	-0.796	-0.001	0.149
Cash holdings	923	0.594	1.367	0.045	0.138	0.422
Cash flows	923	-1.717	3.295	-1.414	-0.223	0.046
Non-cash assets	923	322.327	1987.362	1.892	9.273	43.636
Low liquidity 3: Firms without CL from 1995 to 2007, Non-Cash Assets>=1						
Internal liquidity	745	-0.254	1.004	-0.194	0.071	0.165
Cash holdings	745	0.355	0.814	0.037	0.112	0.306
Cash flows	745	-0.673	1.775	-0.571	-0.08	0.071
Non-cash assets	745	399.234	2205.409	4.804	15.862	60.669

Table III. With or without credit line access and internal liquidity, full sample

This table reports test results on the relationship between credit line access and internal liquidity. The dependent variable *Access to CL* is a dummy, whose value is equal to one for CL borrowers in Group 1A, 1B, and 2 in Table II, or zero for firms without credit line access records from 1995-2007 in Group 3. Independent variables are *Internal liquidity =(CHE+OIBDP)/(AT–CHE), Size =Log(AT–CHE), Market-to-Book =(AT–BE+PRCC_F*CSHO–CHE)/(AT–CHE), Cash flows =OIBDP/(AT–CHE), and Cash holdings =CHE/(AT–CHE)* . Firms with non-cash assets lower than $1 million are dropped. All independent variables are averaged for each firm in 2002-2004 and winsorized at 2.5% on both sides. Firms with non-cash assets smaller than $1 million are dropped. All tests are cross-sectional at the firm level. Regressions report the robust standard error in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A

	Dependent variable: Access to CL			
	(1)	(2)	(3)	(4)
Internal liquidity	-0.477***	-0.510***	-0.462***	-0.386***
	(0.052)	(0.082)	(0.085)	(0.087)
Size		0.668***	0.646***	0.644***
		(0.027)	(0.028)	(0.029)
Market-to-Book			-0.036**	-0.029*
			(0.016)	(0.015)
Observations	3236	3236	3236	3236
Industry FE	No	No	No	Yes

Panel B

	Dependent variable: Access to CL			
	(1)	(2)	(3)	(4)
Cash flows	0.825***		0.645**	0.577**
	(0.280)		(0.268)	(0.243)
Cash holdings		-0.878***	-0.877***	-0.759***
		(0.148)	(0.159)	(0.156)
Size	0.597***	0.611***	0.581***	0.592***
	(0.031)	(0.028)	(0.032)	(0.032)
Market-to-Book	-0.045**	0.011	0.032*	0.033*
	(0.022)	(0.016)	(0.018)	(0.018)
Observations	3,236	3,236	3,236	3,236
Industry FE	No	No	No	Yes

Table IV. Firms above internal liquidity reference subgroup

This table reports test results on the relationship between credit line access and internal liquidity for sample firms above internal liquidity reference. The dependent variable *Access to CL* is a dummy, whose value is equal to one for CL borrowers in Group 1A, 1B, and 2 in Table II, or zero for firms without credit line access records from 1995-2007 in Group 3. Independent variables are *Internal liquidity =(CHE+OIBDP)/(AT–CHE), Size =Log(AT–CHE), Market-to-Book =(AT–BE+PRCC_F*CSHO–CHE)/(AT–CHE), Cash flows =OIBDP/(AT–CHE), and Cash holdings =CHE/(AT–CHE)*. Firms with non-cash assets lower than $1 million are dropped. All independent variables are averaged for each firm in 2002-2004 and winsorized at 2.5% on both sides. Firms with non-cash assets smaller than $1 million are dropped. All tests are cross-sectional at the firm level. Regressions report the robust standard error in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. CL borrowers in Group 1A, 1B, and 2 with firms without CL in Group 3, Table II Panel A

	Dependent variable: Access to CL			
	(1)	(2)	(3)	(4)
Internal liquidity	-1.285***	-0.668***	-0.755***	-0.580***
	(0.150)	(0.126)	(0.128)	(0.131)
Size		0.524***	0.532***	0.574***
		(0.034)	(0.036)	(0.038)
Market-to-Book			0.027	0.020
			(0.018)	(0.018)
Observations	1,733	1,733	1,733	1,733
Industry FE	No	No	No	Yes

Panel B. CL borrowers in Group 1A, 1B, and 2 with firms without CL in Group 3, Table II Panel A

	Dependent variable: Access to CL			
	(1)	(2)	(3)	(4)
Cash flows	0.808**		0.019	0.189
	(0.364)		(0.340)	(0.327)
Cash holdings		-0.894***	-0.889***	-0.697***
		(0.156)	(0.165)	(0.168)
Size	0.531***	0.495***	0.495***	0.540***
	(0.037)	(0.036)	(0.037)	(0.039)
Market-to-Book	-0.028	0.058**	0.058**	0.052**
	(0.023)	(0.024)	(0.024)	(0.024)
Observations	1,733	1,733	1,733	1,733
Industry FE	No	No	No	Yes

Panel C. CL borrowers in Group 1A with borrowers with unexpired CL in Group 2, Table II Panel A

	Dependent variable: New CL Contract			
	(1)	(2)	(3)	(4)
Cash flows	0.848**		0.371	0.613
	(0.356)		(0.435)	(0.485)
Cash holdings		-0.870**	-0.755*	-0.544
		(0.376)	(0.418)	(0.407)
Size	0.407***	0.383***	0.386***	0.435***
	(0.050)	(0.051)	(0.051)	(0.057)
Market-to-Book	0.083**	0.166***	0.160***	0.137**
	(0.038)	(0.057)	(0.057)	(0.055)
Observations	537	537	537	537
Industry FE	No	No	No	Yes

Panel D. CL borrowers in Group 1B with borrowers with unexpired CL in Group 2, Table II Panel A

Panel D				
	Dependent variable: New CL Contract			
	(1)	(2)	(3)	(4)
Cash flows	0.192		0.240	0.198
	(0.331)		(0.367)	(0.387)
Cash holdings		-0.006	0.064	-0.008
		(0.200)	(0.216)	(0.234)
Size	-0.272***	-0.271***	-0.269***	-0.244***
	(0.049)	(0.050)	(0.050)	(0.054)
Market-to-Book	0.009	0.001	0.003	0.006
	(0.033)	(0.040)	(0.040)	(0.041)
Observations	533	533	533	533
Industry FE	No	No	No	Yes

Table V. Firms below the internal liquidity reference

This table reports test results on the relationship between credit line access and internal liquidity for sample firms below the internal liquidity reference. The dependent variable *Access to CL* is a dummy, whose value is equal to one for CL borrowers in Group 1A, 1B, and 2 in Table II, or zero for firms without credit line access records from 1995-2007 in Group 3. Independent variables are *Internal liquidity =(CHE+OIBDP)/(AT–CHE), Size =Log(AT–CHE), Market-to-Book =(AT–BE+PRCC_F*CSHO–CHE)/(AT–CHE), Cash flows =OIBDP/(AT–CHE), and Cash holdings =CHE/(AT–CHE)*. Firms with non-cash assets lower than $1 million are dropped. All independent variables are averaged for each firm in 2002-2004 and winsorized at 2.5% on both sides. Firms with non-cash assets smaller than $1 million are dropped. All tests are cross-sectional at the firm level. Regressions report the robust standard error in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. CL borrowers in Group 1A, 1B, and 2 with firms without CL in Group 3, Table II Panel B

	Dependent variable: Access to CL			
	(1)	(2)	(3)	(4)
Internal liquidity	4.522***	1.272***	1.099***	1.448***
	(0.418)	(0.402)	(0.396)	(0.415)
Size		0.754***	0.744***	0.697***
		(0.047)	(0.050)	(0.051)
Market-to-Book			-0.029	-0.007
			(0.035)	(0.030)
Observations	1,503	1,503	1,503	1,503
Industry FE	No	No	No	Yes

Panel B. CL borrowers in Group 1A, 1B, and 2 with firms without CL in Group 3, Table II Panel B

	Dependent variable: Access to CL			
	(1)	(2)	(3)	(4)
Cash flows	1.950**		1.643**	1.656***
	(0.950)		(0.665)	(0.620)
Cash holdings		-2.792**	-1.808*	-1.444
		(1.170)	(1.020)	(1.104)
Size	0.672***	0.726***	0.682***	0.668***
	(0.057)	(0.046)	(0.059)	(0.058)
Market-to-Book			0.080***	0.084***
			(0.024)	(0.024)
Observations	1,503	1,503	1,503	1,503
Industry FE	No	No	No	Yes

Panel C. CL borrowers in Group 1A with borrowers with unexpired CL in Group 2, Table II Panel B

	Dependent variable: New CL Contract			
	(1)	(2)	(3)	(4)
Cash flows	3.182		2.476	1.875
	(1.937)		(2.176)	(2.457)
Cash holdings		-3.421*	-2.497	-3.840
		(1.799)	(2.065)	(2.437)
Size	0.595***	0.602***	0.593***	0.645***
	(0.060)	(0.060)	(0.060)	(0.063)
Market-to-Book	0.110	0.128	0.125	0.137
	(0.091)	(0.129)	(0.110)	(0.102)
Observations	559	559	559	559
Industry FE	No	No	No	Yes

Panel D: CL borrowers in Group 1B with borrowers with unexpired CL in Group 2, Table II Panel B

	Dependent variable: New CL Contract			
	(1)	(2)	(3)	(4)
Cash flows	-0.299		-1.333	-1.028
	(0.716)		(0.881)	(0.916)
Cash holdings		-1.085	-2.448*	-2.206
		(0.920)	(1.315)	(1.496)
Size	-0.193***	-0.204***	-0.199***	-0.216***
	(0.050)	(0.050)	(0.050)	(0.057)
Market-to-Book	-0.084	-0.010	-0.054	-0.045
	(0.070)	(0.066)	(0.059)	(0.056)
Observations	522	522	522	522
Industry FE	No	No	No	Yes

Table VI. Low cash flows and bank rejections

This table reports test results on the relationship between credit line access and low cash flows. The dependent variable *Access to CL* is a dummy, whose value is equal to one for CL borrowers in Group 1A, 1B, and 2 in Table II, or zero for firms without credit line access records from 1995-2007 in Group 3. The main independent variable is a dummy Low cash flows, which is equal to one if a firm's average return on tangible assets (OIBDP/(AT-CHE)) is less than 6% from 2002 to 2004, or zero otherwise. The other independent variables are *Size =Log(AT–CHE), Market-to-Book =(AT–BE+PRCC_F*CSHO–CHE)/(AT–CHE), and Cash holdings =CHE/(AT–CHE)*. Firms with non-cash assets lower than $1 million are dropped. All independent variables are averaged for each firm in 2002-2004 and winsorized at 2.5% on both sides. Firms with non-cash assets smaller than $1 million are dropped. All tests are cross-sectional at the firm level. Regressions report the robust standard error in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. CL borrowers in Group 1A, 1B, and 2 with firms without CL in Group 3, Table II Panel A

	Dependent variable: Access to CL			
	(1)	(2)	(3)	(4)
Low cash flows	-1.168***	-0.769***	-0.769***	-0.771***
	(0.170)	(0.173)	(0.173)	(0.187)
Cash holdings		-0.701***	-0.701***	-0.562***
		(0.152)	(0.152)	(0.153)
Size	0.493***	0.464***	0.464***	0.511***
	(0.035)	(0.036)	(0.036)	(0.039)
Market-to-Book	-0.026	0.050**	0.050**	0.044*
	(0.019)	(0.024)	(0.024)	(0.024)
Observations	1,733	1,733	1,733	1,733
Industry FE	No	No	No	Yes

Panel B. CL borrowers in Group 1A, 1B, and 2 with firms without CL in Group 3, Table II Panel B

	Dependent variable: Access to CL			
	(1)	(2)	(3)	(4)
Low Cash flows	-1.170***	-1.009***	-1.009***	-0.950***
	(0.159)	(0.185)	(0.185)	(0.193)
Cash holdings		-1.586*	-1.586*	-1.507
		(0.875)	(0.875)	(0.922)
Size	0.657***	0.651***	0.651***	0.643***
	(0.049)	(0.049)	(0.049)	(0.051)
Market-to-Book	-0.025	0.019	0.019	0.021
	(0.031)	(0.024)	(0.024)	(0.024)
Observations	1,503	1,503	1,503	1,503
Industry FE	No	No	No	Yes

Table VII. Firms above the internal liquidity reference: cash flow volatility

This table reports test results on the relationship between credit line access and cash flow volatility. The dependent variable *Access to CL* is a dummy, whose value is equal to one for CL borrowers in Group 1A, 1B, and 2 in Table II, or zero for firms without credit line access records from 1995-2007 in Group 3. Independent variables are *Internal liquidity =(CHE+OIBDP)/(AT–CHE), Size =Log(AT–CHE), Market-to-Book =(AT–BE+PRCC_F*CSHO–CHE)/(AT–CHE), Cash flows =OIBDP/(AT–CHE), and Cash holdings =CHE/(AT–CHE)* and Cash flow volatility which is measured as the standard deviation of cash flows of a firm over the past 10 years (1995-2004). As we require at least 8 data points to calculate a firm's cash flow volatility, 437 firms from above the sample median drop out. Firms with non-cash assets lower than $1 million are dropped. All independent variables are averaged for each firm in 2002-2004 and winsorized at 2.5% on both sides. Firms with non-cash assets smaller than $1 million are dropped. All tests are cross-sectional at the firm level. Regressions report the robust standard error in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A

	(1)	(2)	(3)	(4)
	Dependent Variable: Access to CL			
Internal liquidity	-1.487***	-0.689***	-0.945***	-0.743***
	(0.199)	(0.168)	(0.180)	(0.183)
Cash flow volatility		-0.988**	-1.404***	-1.258***
		(0.455)	(0.459)	(0.452)
Size		0.527***	0.528***	0.569***
		(0.043)	(0.043)	(0.044)
Market-to-Book			0.096***	0.081***
			(0.028)	(0.028)
Observations	1,296	1,296	1,296	1,296
Industry FE	No	No	No	Yes

Panel B

	(1)	(2)	(3)	(4)
	Dependent Variable: Access to CL			
Cash flows	0.181		-0.561	-0.324
	(0.443)		(0.373)	(0.361)
Cash flow volatility	-1.507***	-0.810*	-1.043**	-0.881*
	(0.543)	(0.425)	(0.462)	(0.458)
Cash holdings		-1.019***	-1.126***	-0.916***
		(0.236)	(0.244)	(0.250)
Size	0.553***	0.517***	0.519***	0.561***
	(0.043)	(0.044)	(0.044)	(0.045)
Market-to-Book	0.006	0.104***	0.108***	0.096***
	(0.031)	(0.034)	(0.032)	(0.033)
Observations	1,296	1,296	1,296	1,296
Industry FE	No	No	No	Yes

Table VIII. Ranking of liquidity sources in 10-K for regular borrowers during the crisis period

This table reports a summary of liquidity source ranking collected from firms' 10-Ks. By reading 10-Ks in 2008 and 2009 for 655 regular credit line borrowers, we identify six popular liquidity sources. They are internal liquidity, cash holdings or cash flows, lines of credit, commercial papers, debt issuance, asset sales, and others. The rank is the sequence that liquidity sources are mentioned in each 10-K. We assume the first source is more important than the second, and so on. For example, if a company 10-K writes as follows: Our sources of liquidity are cash and cash flows, lines of credit, commercial papers, and debt issuance. For this company, internal liquidity is rank 1, lines of credit rank 2, commercial papers rank 3, and debt issuance rank 4. The number "835" refers to 835 firm-year 10-K filings that have mentioned cash or cash flows as their source of liquidity, of which 829 10-Ks are in rank 1. In 4 10-Ks, it is rank 2, and in 2 10-Ks as rank 3. The Weighted Average Rank is defined as $\frac{\sum_{i=1}^{6} \text{Rank}_i + \textit{number of firms}_i}{\sum_{i=1}^{6} \text{number of firms}_i}$. The sample period covers the year 2008 and year 2009.

Source and rank of liquidity							
Internal liquidity, cash holdings or cash flows							
Rank		1	2	3	4	5	6
Number of firm-year	835	829	4	2	0	0	0
Weighted Average Rank				1.01			
Lines of credit							
Rank		1	2	3	4	5	6
Number of firm-year	788	9	701	71	7	0	0
Weighted Average Rank				2.1			
Commercial papers							
Rank		1	2	3	4	5	6
Number of firm-year	115	0	55	59	1	0	0
Weighted Average Rank				2.53			
Debt issuance							
Rank		1	2	3	4	5	6
Number of firm-year	53	0	9	29	15	0	0
Weighted Average Rank				3.11			
Asset sales							
Rank		1	2	3	4	5	6
Number of firm-year	24	0	5	14	3	2	0
Weighted Average Rank				3.08			
Others							
Rank		1	2	3	4	5	6
Number of firm-year	57	0	25	20	12	0	0
Weighted Average Rank				2.77			

Table IX. Drawdown in crisis, regular borrowers, above the internal liquidity reference

This table reports regression results on the relationship between access to credit lines and total liquidity during the two-year crisis period. The sample includes regular credit line borrowers in Table II Panel A Group 1A and Group 3 above the internal liquidity reference. The dependent variable in Panel A is *Total liquidity I =(CHE + OIBDP+ drawdown CL)/(AT-CHE)*, and the dependent variable in Panel B is *Total liquidity II=(CHE+OIBDP + total CL)/(AT-CHE)*. The total CL and drawdown CL are collected from 10-Ks in 2008 and 2009. For firms in Group 3 without credit line access, the total CL and drawdown CL are equal to zero. The key independent variable Access to CL is a dummy variable equal to one for firms that are regular CL borrowers in Group 1A, or zero for firms in Group 3. Control variables are *Size =Log(AT–CHE), and Market-to-Book =(AT–BE+PRCC_F*CSHO–CHE)/(AT–CHE)*. Firms with non-cash assets smaller than $1 million are dropped. All variables are averaged for each firm in 2008-2009. All regressions use the robust standard error. Standard errors are reported in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Total Liquidity I

	Dependent variable: Total liquidity I			
	(1)	(2)	(3)	(4)
Access to CL	-0.349***	-0.114**	-0.131***	-0.024
	(0.036)	(0.047)	(0.044)	(0.082)
Size		-0.062***	-0.040***	-0.032***
		(0.014)	(0.013)	(0.012)
Market-to-Book			0.051***	0.045***
			(0.013)	(0.007)
Observations	1,208	1,208	1,208	1,208
Adj R-squared	0.020	0.042	0.087	0.137
Industry FE	No	No	No	Yes

Panel B. Total Liquidity II

	Dependent variable: Total liquidity II			
	(1)	(2)	(3)	(4)
Access to CL	-0.208***	0.037	0.020	0.126**
	(0.038)	(0.048)	(0.045)	(0.050)
Size		-0.064***	-0.042***	-0.034***
		(0.014)	(0.013)	(0.013)
Market-to-Book			0.051***	0.046***
			(0.014)	(0.014)
Observations	1,208	1,208	1,208	1,208
Adj, R-squared	0.007	0.030	0.077	0.126
Industry FE	No	No	No	Yes

Table X. Drawdown in crisis, regular borrowers, below the internal liquidity reference

This table reports regression results on the relationship between access to credit lines and total liquidity during the two-year crisis period. The sample includes regular credit line borrowers in Table II Panel B Group 1A and Group 3 below the internal liquidity reference. The dependent variable in Panel A is *Total liquidity I =(CHE + OIBDP+ drawdown CL)/(AT-CHE)*, and the dependent variable in Panel B is *Total liquidity II=(CHE+OIBDP + total CL)/(AT-CHE)*. The total CL and drawdown CL are collected from 10-Ks in 2008 and 2009. For firms in Group 3 without credit line access, the total CL and drawdown CL are equal to zero. The key independent variable Access to CL is a dummy variable equal to one for firms that are regular CL borrowers in Group 1A, or zero for firms in Group 3. Control variables are *Size =Log(AT–CHE), and Market-to-Book =(AT–BE+PRC_F*CSHO–CHE)/(AT–CHE)*. Firms with non-cash assets smaller than $1 million are dropped. All variables are averaged for each firm in 2008-2009. All regressions use the robust standard error. Standard errors are reported in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

Panel A. Total Liquidity I

	Dependent variable: Total liquidity I			
	(1)	(2)	(3)	(4)
Access to CL	0.254***	-0.147***	-0.040	-0.033
	(0.025)	(0.041)	(0.034)	(0.059)
Size		0.085***	0.044***	0.052***
		(0.011)	(0.009)	(0.010)
Market-to-Book			-0.047***	-0.050***
			(0.011)	(0.005)
Observations	1,025	1,025	1,025	1,025
Adj R-squared	0.034	0.104	0.188	0.209
Industry FE	No	No	No	Yes

Panel B. Total Liquidity II

	Dependent variable: Total liquidity II			
	(1)	(2)	(3)	(4)
Access to CL	0.383***	-0.003	0.106***	0.111***
	(0.026)	(0.042)	(0.035)	(0.035)
Size		0.082***	0.040***	0.047***
		(0.011)	(0.009)	(0.009)
Market-to-Book			-0.047***	-0.050***
			(0.011)	(0.010)
Observations	1,025	1,025	1,025	1,025
Adj, R-squared	0.073	0.134	0.216	0.235
Industry FE	No	No	No	Yes

Table XI. Drawdown in crisis, regular borrowers, above or below the internal liquidity reference

This table reports regression results on the relationship between CL drawdown and internal liquidity for regular borrowers during the two-year crisis period. The sample includes the regular credit line borrowers in Table II Panel A Group 1A and Panel B Group 1B. The dependent variable is *CL Drawdown =(Drawdown CL)/(AT-CHE)*. The drawdown CL is collected from 10-Ks in 2008 and 2009. The key independent variable *Above liquidity reference* is a dummy which is equal to one if a regular borrower is in the category of above the internal liquidity reference or zero otherwise. Control variables are *Size =Log(AT–CHE), and Market-to-Book =(AT–BE+PRC_F*CSHO–CHE)/(AT–CHE)*. Firms with non-cash assets smaller than $1 million are dropped. All variables are averaged for each firm in 2008-2009. All regressions use the robust standard error. Standard errors are reported in the parentheses. *, **, and *** indicate statistical significance at the 10%, 5%, and 1% level, respectively.

	Dependent variable: CL Drawdown			
	(1)	(2)	(3)	(4)
Above liquidity reference	-0.013***	-0.013***	-0.013***	-0.013***
	(0.004)	(0.004)	(0.004)	(0.004)
Size		-0.017***	-0.017***	-0.018***
		(0.001)	(0.001)	(0.001)
Market-to-Book			0.001	0.003
			(0.003)	(0.003)
Observations	422	422	422	422
Adj R-squared	0.025	0.267	0.268	0.314
Industry FE	No	No	No	Yes

Appendix A 10-K questionnaire for liquidity on regular borrowers of lines of credit

We design a six-question questionnaire. The questions are about corporate liquidity, including internal liquidity and lines of credit. We survey 10-Ks for 655 regular borrowers of lines of credit in the years 2008 and 2009. Sample answers that we have collected are summarized below.

[1] What are the top sources of liquidity for your company?

(a) Operation cash, cash on hand, or marketable securities.

(b) Revolving lines of credit

(c) Commercial paper.

(d) (Long-term) Debt issuance.

(e) Asset sales.

(f) Other.

[2] How would you describe your company's overall liquidity condition in 2008/2009?

(a) Some sample wordings for sufficient liquidity are "sufficient" or "adequate liquidity" or "liquidity could satisfy investment needs" or "we are comfortable with our ability to finance our operation . . . ".

(b) Some sample wordings for constrained liquidity are "negatively affected", "insufficient", "put significant pressure on liquidity".

[3] Did you find it difficult to access external credit markets in 2008/2009?

(a) Some sample wordings for not difficult to access external credit are "not materially impacted", "sufficient borrowing capacity".

(b) ome sample wordings for difficult to access external credit are "Because the current market for A3 commercial paper is very limited, it would be very difficult to rely on the use of this market as a meaningful source of liquidity."

[4] Did the major negative shock to your business come from the supply side or demand side?

(a) Some sample wordings for supply shock are that the insufficient liquidity is caused by "bank failure".

(b) Some sample wordings for demand shocks, "executing strategic "trough" plans", "reducing planned capital expenditures". We code a supply shock if the problem is because banks cut lending. It is a demand shock if the borrowers reduce borrowing activities because of their own problems or lower-than-expected business opportunities.

[5] Did your company have specific relationship bank(s) that was(were) in trouble? If so, did you search for a replacement?

[6] What is your company's total lines of credit? How much did your company draw down?

(a) We follow total credit line = drawdown credit line + undrawn credit line.

(b) In case that any two of the three numbers are available in 10-K, we calculate the third one.