A New Perspective on Bank-Dependency: The Liquidity
Insurance Channel*

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Abstract

We propose a novel channel through which shocks to bank health affect real economic activity. This channel arises from the provision of liquidity insurance from banks to firms, through pre-committed credit lines. While bank-dependency is usually associated with low credit quality, liquidity insurance through credit lines is most common for large, high credit quality firms. We propose a model that matches this cross-section of bank dependency and liquidity insurance, and test its empirical implications. Shocks to bank health affect firms that rely on credit lines in two different ways. First, weak banks are less likely to waive covenant violations, and more likely to withhold funds under pre-committed lines of credit. This effect induces covenant violators to switch to bond financing rather than relying on credit line drawdowns, with negative consequences for their investment and performance. Second, firms that rely on credit lines, but which have not violated covenants, tend to switch from credit lines to cash. This substitution from credit lines into cash by high quality firms can amplify the negative shock to bank health, by draining bank liquidity. This amplification effect can contaminate the provision of regular loans to bank-dependent firms, and thereby cause large negative effects on real activity.

Key words: Liquidity management, cash holdings, liquidity risk, investment, lending channel, credit lines.
JEL classification: G21, G31, G32, E22, E5.

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1 Introduction

The standard bank lending channel predicts that bank health may affect investment and other real variables of financially constrained firms that cannot access other types of external funds. However, bank credit lines are more commonly used by large, profitable, high credit quality firms (Sufi, 2009, Acharya et al., 2014). Small, financially constrained firms tend to rely on cash for their liquidity management.

Bank credit lines are distinct from standard term loans in that they provide liquidity insurance, allowing firms to access bank financing in states of world in which their financial performance deteriorates. As a result, firms that rely on credit lines may not draw down on credit lines often, but at the same time credit line access can be very important for them in bad states of the world. Since negative shocks to bank health affect their ability to honor credit line drawdowns, high credit quality firms may also be affected by such shocks. We call this link between bank health and the real economy that operates through liquidity insurance provision the (bank) "liquidity insurance channel".

We provide a model of the liquidity insurance channel and test its empirical predictions. The model considers both the standard motivation for bank lending to financially weak firms, and a framework for liquidity management. The bank lending model is based on Holmstrom and Tirole (1997), while the liquidity insurance framework is similar to that in Holmstrom and Tirole (1998). The key innovation is to consider both the decision to borrow from a bank or not, and the decision of how to hold liquidity, simultaneously.

In the model, the benefit of bank lending is to increase pledgeable income through monitoring. Since monitoring is costly, firms borrow from a bank only when the marginal benefit of increasing investment is high. Besides funding current investment, firms must also plan for a future liquidity shortfall, by holding pre-committed financing (liquidity insurance). Using cash to insure liquidity is costly because of a liquidity premium, while relying on credit lines exposes the firm to the risk of credit line revocation.

The key intuition of the model is that firms with high credit quality have both a lower benefit of bank monitoring, and a low cost of credit line revocation. These firms are less financially constrained and thus invest at higher levels. Under decreasing returns to scale, the marginal benefit of using bank monitoring to increase investment is lower. At the same time, these firms also have lower liquidity risk, either because their probability of facing a liquidity shock is lower, or because the losses associated with not having sufficient liquidity are smaller. Thus, high credit quality firms

\[1 \text{ Acharya and al. (2014) provide evidence on the frequency of credit line drawdowns.}\]
rely on credit lines for liquidity insurance but do not benefit from using bank debt for regular borrowing. Low credit quality firms rely on bank debt, and are also more likely to choose cash for their liquidity management.\(^2\)

We also use the model to study the effects of shocks that affect bank health. Standard literature focuses on the bank lending channel, whereby an increase in bank capital reduces the cost of monitoring for low credit quality firms and thereby affects real activity (e.g., Holmstrom and Tirole, 1997). We show that liquidity insurance provision through credit lines is another channel through which bank health can affect aggregate activity.

The reason why bank health matters for firm liquidity management is that banks must have sufficient liquidity to honor credit lines in bad aggregate states of the world, in which many or most firms are likely to demand liquidity.\(^3\) Thus, negative shocks to bank liquidity have both an ex-post effect on investment and an ex-ante effect on liquidity management. Ex-post, if the shocks to bank health coincide with negative aggregate shocks, then banks’ ability to honor credit line drawdowns is compromised. This effect tightens financing constraints on firms that rely on credit lines for their liquidity management, and may have real consequences on these firms. Shocks to bank health also create an ex-ante effect on liquidity management. Following negative shocks to bank liquidity, firms anticipate that banks will be less able to honor credit lines in the future, and thus increase their demand for cash. If holding cash is costly, this ex-ante effect can also have negative consequences for real activity.

Our model also encompasses the traditional bank lending channel that previous literature has focused on. As in Holmstrom and Tirole (1997), negative shocks to bank health affect banks’ ability to make loans to low credit quality firms, and thereby affect these firms’ investment in an equilibrium when they are bank-dependent. Our model suggests that the liquidity insurance channel can amplify the effects of this lending channel. By substituting credit lines for cash, high credit quality firms drain bank liquidity, and undermine banks’ ability to provide loans to bank-dependent firms. Since low quality, bank-dependent firms are highly sensitive to negative shocks, this contamination effect from liquidity insurance to regular lending can have large effects in real activity.

We test the key empirical predictions of our model of the liquidity insurance channel. We employ a combination of rich datasets covering the sample period 2002-2011, including a novel

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\(^2\) If a firm relies on credit lines for liquidity management, there will be states of the world in which it will draw on the credit line and use bank debt. But for high credit quality firms these states of the world do not happen very often. Thus, at any point of time they will have less bank debt than lower credit quality firms that rely on banks for their regular financing.

\(^3\) Bank liquidity is irrelevant in the absence of aggregate shocks, as in Acharya, Almeida and Campello (2013).
database of information about the precise reaction of banks to credit line covenant violations of U.S. listed firms, a database of detailed U.S. firms’ capital structure and undrawn credit availability and usage, and bank financial health measures.

To measure the *ex-post* effect of shocks to bank health, we focus on a sample of firms that have violated covenants. Following a covenant violation, even large and high-quality firms may find it difficult to substitute credit lines for other forms of financing, and may thus be very sensitive to the revocation of credit lines. On the other hand, the bank does have the discretion to waive the violation and honor credit line drawdowns. Thus, the waiver-revocation decision is an important margin through which bank decisions may affect firms that are dependent on credit lines.

Consistent with this hypothesis, we find that banks in financial distress are less likely to waive covenants following violations, and thus are more likely to withhold funds under precommitted lines of credit. These effects are particularly strong during the recent financial crisis. Banks’ decision to waive covenants also have significant effects on the capital structure and investment of covenant violators. Firms that lose access to lines of credit due to a negative shock to bank health switch to bond issuance, but cannot fully compensate for the lost bank finance. As a result, these firms invest and hire less, and perform worse than similar firms that had covenants waived because they were borrowing from strong banks.

To measure the *ex-ante* effect of shocks to bank health, we focus on a sample of credit line users that have *not* violated covenants. Even when these firms are not currently financially constrained, they can react to the shock by changing their liquidity management. Because they anticipate that weak banks will be less able to honor credit lines in the future, they should increase their demand for cash and reduce their reliance on credit lines. We find evidence consistent with this implication. In particular, firms with high credit quality substitute credit lines for cash during the recent financial crisis, but not in other normal periods.

Next, we track the implications of this ex-ante effect for real activity. While high quality firms are unlikely to be much affected by negative shocks, the model suggests two mechanisms through which their liquidity management behavior can *contaminate* low quality firms. The substitution of credit lines for cash by high quality firms contributes to a decrease in bank liquidity, because these firms drawdown their existing credit lines with weak banks (a type of run on credit lines), and because they stop paying commitment fees. This decrease in bank liquidity reduces lending and hurts bank-dependent firms. We find evidence consistent with this hypothesis as well.

Overall, our results suggest that the provision of bank liquidity insurance by banks is an important channel through which shocks to bank health affect real economic activity.
An important strand of the theoretical banking literature has focused on the role of banks in improving resource allocation by creating pledgeable income through a reduction in private benefits, improved project screening, and other mechanisms (Fama (1986), Houston and James (1996) and Holmstrom and Tirole (1997)) and analyzed the macroeconomic implications of bank financial constraints that limit their ability to perform this role (Brunnermeier and Sannikov (2014), Gertler and Kiyotaki (2013), Adrian and Shin (2013)). Another strand has instead addressed the liquidity provision by banks to the corporate sector through credit lines (Boot, Greenbaum, and Thakor (1993), Kashyap, Rajan and Stein (2002) and Gatev and Strahan (2006)). Our theory contributes to these literatures by bringing together both aspects of financial intermediation and considering firms’ external financing and liquidity management problems in the same framework, and also by exploring the macroeconomic implications of banks’ liquidity provision role.

Our work is also related to the empirical literature that shows that a deterioration of the financial health of banks affects its bank dependent borrowers through a contraction in credit supply (Kashyap and Stein (2000), Khwaja and Mian (2008), Paravisini (2008), and Jimenez, Ongena, Peydró and Saurina (2012)). We build on this literature by providing evidence of a novel source of bank financial fragility (exposure to credit line drawdowns) that has implications for bank dependent borrowers.

Our work also builds on the growing empirical literature on the role of credit lines in corporate finance (Suﬁ (2009), Yun (2009), Campello, Giambona, Graham, and Harvey (2010), Acharya, Almeida and Campello (2012), and Acharya, Almeida Ippolito and Perez (2014)). The most relevant for our paper are Suﬁ (2009), who shows that firms with low profitability and high cash ﬂow risk are less likely to use credit lines and more likely to use cash for liquidity management because they face a greater risk of covenant violation and credit line revocation, and Acharya, Almeida, Ippolito and Perez (2014), who show that credit line revocation following negative proﬁtability shocks can be an optimal way to incentivize ﬁrms to not strategically increase liquidity risk, and also provides incentives for the bank monitoring that can contain the illiquidity transformation problem. We contribute to this literature by exploring the role of bank ﬁnancial health in determining the ex-post access to credit lines and the ex-ante liquidity management policy of ﬁrms.

2 A model of bank lending and liquidity insurance provision

Here we describe a framework which incorporates both liquidity management frictions, and bank monitoring. This section characterizes an individual ﬁrm’s ﬁnancing choices. The next section introduces an equilibrium framework to characterize the roles of bank capital and liquidity in the
2.1 Basic assumptions

Each firm invests \( I \) at date 0. Entrepreneurs’ date-0 wealth is \( A > 0 \). Investment produces a payoff equal to \( R(I) \) with probability \( p \) if it is continued until the final date, where the function \( R(.) \) exhibits decreasing returns to scale \((R' > 0, R'' < 0)\). With probability \( 1 - p \), the project produces nothing. The probability \( p \) depends on entrepreneurial effort. High effort produces a probability \( p_H \), while low effort produces \( p_L < p_H \) but also produces private benefits \( BI \).

Given this set up, the entrepreneur will only put high effort if her share of the cash flow (call it \( R_E \)) is greater than a minimum amount:

\[
p_H R_E \geq p_L R_E + BI, \tag{1}
\]

so that the project’s pledgeable income is:

\[
\rho_0(I) = p_H \left[ R(I) - \frac{BI}{p_H - p_L} \right]. \tag{2}
\]

The investment opportunity also requires an additional investment at date 1, of uncertain size. This additional investment represents the firms’ liquidity need at date 1. The date 1 investment can be either equal to \( \rho I \), with probability \( \lambda \), or 0, with probability \((1 - \lambda)\). If the date-1 investment is not made the project is liquidated (no partial liquidation). Liquidation at date-1 produces a payoff equal to \( \tau I \geq 0 \). We assume that it is efficient to continue the investment in state \( \lambda \):

\[
p_H R(I) - \rho I > \tau I, \tag{3}
\]
in the relevant range for \( I \).

There is no discounting (the required rate of return is one). Firms can raise \((I - A)\) from a bank, or directly from individuals.

2.2 Optimal investment level

Given these assumptions, the firm solves the following optimization problem:

\[
\max p_H R(I) - (1 + \lambda \rho) I \quad \text{s.t.} \quad (1 + \lambda \rho) I \leq A + \rho_0(I) \tag{4}
\]

\( ^4 \)Bank monitoring will reduce private benefits to \( b < B \), at a cost \( c \), as we model below.
The optimal solution is as follows. Define the first best investment level as:

$$p_H R'(I^{FB}) = 1 + \lambda \rho. \quad (5)$$

If this investment level obeys the budget constraint, that is, if $(1 + \lambda \rho) I^{FB} \leq A + \rho_0(I^{FB})$, then investment is equal to $I^{FB}$ and the payoff is maximized at $U^{FB}$. Otherwise, the firm must reduce investment to the level that satisfies the budget constraint:

$$(1 + \lambda \rho)I^{SB} = A + \rho_0(I^{SB}), \quad (6)$$

obtaining the payoff:

$$U^{SB} = p_H R(I^{SB}) - (1 + \lambda \rho)I^{SB}. \quad (7)$$

We have that $U^{SB} < U^{FB}$, and $I^{SB} < I^{FB}$.

The firm has the option not to continue the project in state $\lambda$, which may allow it to increase investment above $I^{SB}$. Denote the maximum payoff obtainable in this case as $U_{\text{max}}^{L}$. We assume that continuation in state $\lambda$ always dominates liquidation. This requires the following assumption:

$$U^{SB} > U_{\text{max}}^{L}, \quad (8)$$

in the relevant range of parameters. This implies that $(I^{SB}, U^{SB})$ represents the second best in the absence of bank monitoring - the maximum payoff attainable given the pledgeable income friction.\footnote{As net worth $A$ decreases, it becomes more likely that assumption 8 is violated. In that case the firm would find it optimal not to continue in state $\lambda$, and save resources to increase date-0 investment. In such a case the firm has no demand for liquidity management, even if assumption 9 below holds. Rampini and Vishwanathan (2010) explore this net worth effect in their paper about risk management - as net worth decreases, we reach a point at which risk (or liquidity) management is no longer optimal. They use this intuition to understand why highly constrained firms do not hedge.}

### 2.3 Liquidity management

The firm may need to hold liquidity (in the form of cash or a credit line) to implement the optimal solution above. Considering the second best solution, liquidity is required when:

$$\rho_0(I^{SB}) < \rho I^{SB}. \quad (9)$$

We denote the firm’s total demand for liquidity by $l(I)$, for a given investment level $I$. If this condition holds, then the firm needs to hold

$$l(I^{SB}) = \rho I^{SB} - \rho_0(I^{SB}) \quad (10)$$
in pre-committed liquidity to avoid liquidation in state $\lambda$.

Firms can hold liquid assets (e.g., treasury bonds) as cash, to meet liquidity needs. Treasury bonds sell at a date-0 price $q$, and pay one dollar in all states of the world in date-1. The firm’s cash demand is denoted by $c(I)$, which is given by:

$$c(I) = l(I).$$

If $q > 1$, then cash implementation introduces additional costs and moves the firm away from the second best. Specifically, holding a level of cash equal to $c(I)$ requires the firm to pay a liquidity premium $(q - 1)c(I)$.

Alternatively, firms can access date-1 liquidity through bank credit lines. Below, we introduce an equilibrium framework that generates the following two frictions in credit line implementation. First, there is a probability of credit line revocation in state $\lambda$. In this case, the firm loses access to liquidity. The bank credit line is available to firms in state $\lambda(1 - \mu)$. Second, the total available credit line is given by $\overline{w}$. Thus, if $l(I) > \overline{w}$, the firm cannot rely only on credit lines for liquidity management for the investment level $I$, and will also need to hold some cash. The firm’s demand for credit lines (denoted by $w(I)$) is then:

$$w(I) = \min[l(I), \overline{w}],$$

and the residual demand for cash from firms that rely on credit lines (denoted by $c_w(I)$) is:

$$c_w(I) = l(I) - w(I).$$

Given these assumptions, firms choose between two alternative liquidity management policies. They can either rely only on cash (and demand $c(I)$ in treasury bonds), or rely on bank credit lines in which case they demand $w(I)$ in credit lines and $c_w(I)$ in cash. The trade-off that firms face is that while cash provides full insurance, it incurs a liquidity premium $(q - 1)c(I)$. Firms can save on the liquidity premium by moving to credit lines (the premium goes down to $(q - 1)c_w(I)$), but they face the risk that credit line access may be revoked in state $\mu$.\footnote{Notice that even a firm that invests at the first best level $I^{FB}$ may need to hold liquidity if $\rho_0(I^{FB}) < \rho I^{FB}$.}

\footnote{Notice that if the firm decides to hold sufficient cash to withstand the liquidity shock in state $\mu$ it must hold $c(I)$ and thus effectively switches to the cash solution (e.g., it has no need for the credit line anymore).}
2.3.1 Cash

The firm’s optimization problem under cash implementation is:

$$\max \, p_H R(I) - (1 + \lambda \rho)I - (q - 1)c(I) \text{ s.t.}$$

$$A + \rho_0(I) \geq (1 + \lambda \rho)I + (q - 1)c(I)$$

(14)

The optimal investment level is given by:

$$p_H R'(I_{\text{max}}^c) = 1 + \lambda \rho + (q - 1)c'(I_{\text{max}}^c),$$

(15)

if the constraint does not bind at $I_{\text{max}}^c$, and:

$$A + \rho_0(I^c) = (1 + \lambda \rho)I^c + (q - 1)c(I^c)$$

(16)

if the constraint binds at $I_{\text{max}}^c$. The firm’s payoff is:

$$U^c = p_H R(I^c) - (1 + \lambda \rho)I^c - (q - 1)c(I^c).$$

(17)

If $q > 1$, we will have $U^c < U^{SB}$, and $I^c < I^{SB}$. The firm is forced to invest less than the second-best because of liquidity premia, reducing its payoff.\(^8\)

2.3.2 Credit lines

The firm’s optimization problem under credit line implementation is:

$$\max (1 - \lambda \mu)p_H R(I) + \lambda \mu \tau I - (1 + \lambda(1 - \mu)\rho)I - (q - 1)c_w(I)$$

$$A + (1 - \lambda \mu)\rho_0(I) + \lambda \mu \tau I \geq (1 + \lambda(1 - \mu)\rho)I + (q - 1)c_w(I)$$

(18)

The maximum investment level is given by:

$$p_H R'(I_{\text{max}}^{LC}) = \frac{1 + \lambda(1 - \mu)\rho - \lambda \mu \tau + (q - 1)c_w'(I_{\text{max}}^{LC})}{1 - \lambda \mu}.$$

(19)

If the constraint binds at $I_{\text{max}}^{LC}$, then we have:

$$A + (1 - \lambda \mu)\rho_0(I^{LC}) + \lambda \mu \tau I^{LC} = (1 + \lambda(1 - \mu)\rho)I^{LC} + (q - 1)c_w(I^{LC})$$

(20)

and:

$$U^{LC} = (1 - \lambda \mu)p_H R(I^{LC}) + \lambda \mu \tau I^{LC} - (1 + \lambda(1 - \mu)\rho)I^{LC} - (q - 1)c_w(I^{LC}).$$

(21)

\(^8\)The firm retains the option not to continue the project in state $\lambda$ and demand zero liquidity. In that case it obtains the payoff $U^L$ that we characterize above. A sufficient condition for this solution to obtain is that $U^c > U_{\text{max}}^L$. 

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2.3.3 Optimal solution

Firms choose credit lines if $U^{LC} > U^c$, and they choose cash if $U^c > U^{LC}$. The solution will generally have the following properties.

By choosing credit lines, firms economize on liquidity and can invest at higher levels ($I^{LC} > I^c$). This effect comes about because credit lines economize on the liquidity premium, and also because credit line revocation increases pledgeability. Withstanding the liquidity shock requires the firm to transfer pledgeable income from other states of the world into state $\lambda$. Credit line revocation reduces the usage of liquidity in state $\lambda$, and increases date-0 investment.

However, the payoff per unit of investment decreases with credit line implementation, because the firm loses the valuable investment in state $\lambda\mu$. Notice that:

$$U^{LC} - U^c = p_H \left[ R(I^{LC}) - R(I^c) \right] - (1 + \lambda \rho)(I^{LC} - I^c) + (q - 1) \left[ c(I^c) - c(I^{LC}) \right] - \lambda \mu [p_H R(I^{LC}) - (\rho + \tau) I].$$

The term $p_H \left[ R(I^{LC}) - R(I^c) \right] - (1 + \lambda \rho)(I^{LC} - I^c)$, which is positive, captures the benefit of increased investment under the credit line implementation. In addition, the credit line reduces cash holdings and thus the liquidity premium to $(q - 1)c(I^{LC})$. However, the credit line also introduces a risk of credit line revocation which is associated with value loss $\lambda \mu [p_H R(I^{LC}) - (\rho + \tau) I]$.

Notice that the value loss with liquidation $\lambda \mu [p_H R(I^{LC}) - (\rho + \tau) I]$ is decreasing with the parameter $\tau$. Thus, firms that have higher $\tau$ should be more likely to rely on credit lines, as we further explore below.$^9$

2.4 Bank monitoring and lending

Assume now that the firm can access monitored financing through bank lending. To isolate the role of bank monitoring, we ignore liquidity management frictions for now, and introduce them in the next section. Thus, the question is whether bank monitoring can improve upon the second best solution $(I^{SB}, U^{SB})$.

By paying a cost $\varphi I$, which is proportional to the size of the investment, the bank can reduce managerial private benefits from $BI$ to $bI$.$^{10}$ Because monitoring is costly, the bank must retain a

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$^9$We would obtain a similar intuition if firms differ according to the probability of a liquidity shock, $\lambda$. High $\lambda$ firms have high expected costs of credit line revocation, and are less likely to rely on credit lines. It is more convenient for modeling purposes to focus on heterogeneity in liquidation costs, as we do below.

$^{10}$This formulation follows Holmstrom and Tirole (1997), with the main difference being that we consider decreasing returns to scale.
stake $R_b$ in the project:

$$p_H R_b - \varphi I \geq p_L R_b, \text{ or } \frac{\varphi I}{p_H - p_L} \
R_b \geq \frac{\varphi I}{p_H - p_L}. \quad (23)$$

This constraint will generally bind, and thus the income that can be pledged to investors other than the bank is now:

$$\rho_0^b(I) = p_H \left[ R(I) - \frac{(b + \varphi)I}{p_H - p_L} \right]. \quad (24)$$

The bank’s ex-ante budget constraint for a given loan level $i_b$ is:

$$i_b + \varphi I \leq p_H R_b = \frac{p_H \varphi I}{p_H - p_L}. \quad (25)$$

### 2.4.1 Excess bank capital

There are two possible cases, depending on whether constraint 25 binds or not. If there is sufficient bank capital in the economy the bank will transfer all rents to the firm ex-ante and the constraint will bind. This means that:

$$i_b^* = i_b^{\max} = \left( \frac{p_H}{p_H - p_L} - 1 \right) \varphi I. \quad (26)$$

In this case the firm must raise $i_b^{\max}$ from the bank, but can raise the remaining required financing from other (non-monitor) investors. Given this, the firm will solve the following problem under bank monitoring:

$$\max p_H R(I) - (1 + \lambda \rho)I - \varphi I \text{ s.t. } A + \rho_0^b(I) \geq [1 + \lambda \rho - \left( \frac{p_H}{p_H - p_L} - 1 \right) \varphi] I \quad (27)$$

If the constraint does not bind, the optimal investment level is given by:

$$p_H R'(I_b^{\max}) = 1 + \lambda \rho + \varphi. \quad (28)$$

If this investment level does not satisfy the budget constraint, we have $I_b < I_b^{\max}$ such that:

$$A + \rho_0^b(I_b) = [1 + \lambda \rho - \left( \frac{p_H}{p_H - p_L} - 1 \right) \varphi] I_b, \quad (29)$$

and the payoff is:

$$U_b = p_H R(I_b) - (1 + \lambda \rho)I_b - \varphi I_b \quad (30)$$
2.4.2 Limited bank capital

This case obtains when the bank cannot lend $i_b^{max}$ to all firms that require bank monitoring, due to a scarcity of bank capital. Suppose that the maximum loan that the bank can make is given by $\overline{i}_b$. We have $i_b^* = \overline{i}_b$, and the firm’s problem becomes:

$$\max p_H R(I) - (1 + \lambda \rho)I - \frac{p_H}{p_H - p_L} \varphi I + \overline{i}_b$$

subject to

$$(1 + \lambda \rho)I \leq A + \rho_0^b(I) + \overline{i}_b$$

The optimal investment level is given by:

$$p_H R(i_b^{max}) = 1 + \lambda \rho + \frac{p_H}{p_H - p_L} \varphi.$$  \hspace{1cm} (32)

If this investment does not satisfy the budget constraint we have:

$$(1 + \lambda \rho)I_b = A + \rho_0^b(I_b) + \overline{i}_b$$ \hspace{1cm} (33)

2.4.3 Optimal solution

For now, assume that there is excess bank capital so that $i_b^* = i_b^{max}$. We will consider the case of limited bank capital later on in the paper.

In this case, firms choose bank monitoring if $U_b > U^{SB}$, and non-bank financing if $U_b < U^{SB}$. Comparing the expressions for $U_b$ and $U^{SB}$ above, one can see that that for the same investment level $I \leq I^{FB}$, $U_b(I) < U^{SB}(I)$. Thus, bank monitoring can only improve the firm’s payoff if it allows the firm to invest at a higher level, $I_b^{max} > I^{SB}$. This condition is necessary but not sufficient for bank monitoring to be optimal, since the payoff $U^{SB}$ is reduced by the monitoring cost $\varphi I_b^{max}$. Bank monitoring is thus a costly way to increase pledgeability and the investment level.

Since the main benefit of bank monitoring is to increase the investment level, this benefit will be higher when firms are more financially constrained (that is, when the feasible investment level without bank monitoring, $I^{SB}$, is low). In this case, the marginal benefit of increasing investment is higher (since $R(.)$ is concave). As in Holmstrom and Tirole (1997), this argument suggests that firms with low initial net worth ($A$) are more likely to use bank monitoring.

2.5 Bank monitoring with liquidity management frictions

With liquidity management frictions, the firm must choose both whether to use monitored financing, and also how to manage liquidity. If the firm does not hire a monitor, the solutions are identical to those characterized above ($U^{LC}$ and $U^c$).
If the firm uses bank monitoring and holds cash, the amount of cash is given by:

\[ c_b(I) = \rho I - \rho_b^b(I), \quad (34) \]

We can follow the steps above to derive the optimal investment level:

\[ p_H R'(I_{b,\text{max}}^c) = 1 + \lambda \rho + \varphi + (q - 1)c_b(I_{b,\text{max}}^c), \quad (35) \]

if the constraint does not bind at \( I_{b,\text{max}}^c \), and:

\[ A + \rho_b^b(I_b^c) = [1 + \lambda \rho - (\frac{p_H}{p_H - p_L} - 1)\varphi]I_b^c + (q - 1)c_b(I_b^c) \quad (36) \]

if the constraint binds at \( I_{b,\text{max}}^c \). The firm’s payoff is:

\[ U_b^c = p_H R(I_b^c) - (1 + \lambda \rho)I_b^c - \varphi I_b^c - (q - 1)c(I_b^c). \quad (37) \]

Similarly, if the firm uses bank monitoring and the credit line we have:

\[ p_H R'(I_{b,\text{max}}^{LC}) = \frac{1 + \lambda(1 - \mu)\rho - \lambda \mu \tau + (1 - \lambda \mu)\varphi + (q - 1)c_w^{LC}(I_{b,\text{max}}^{LC})}{1 - \lambda \mu}, \quad (38) \]

and:

\[ (1 + \lambda(1 - \mu)\rho - \lambda \mu \tau - (1 - \lambda \mu)(\frac{p_H}{p_H - p_L} - 1)\varphi)I_b^{LC} + (q - 1)c_w(I_b^{LC}) = A + (1 - \lambda \mu)\rho_b^b(I_b^{LC}), \quad (39) \]

The payoff is:

\[ U_b^{LC} = (1 - \lambda \mu)(p_H R(I_b^{LC}) - \varphi I_b^{LC}) + \lambda \mu \tau I_b^{LC} - [1 + \lambda(1 - \mu)\rho]I_b^{LC} - (q - 1)c_w(I_b^{LC}). \quad (40) \]

**2.5.1 Optimal solution**

The firm chooses the solution that maximizes its payoff. That is, it picks the maximum payoff across \( U^{LC}, U^c, U_b^{LC}, \) and \( U_b^c \). For example, if the highest payoff among these four cases is \( U_b^c \), the firm chooses bank monitoring, and uses cash holdings for liquidity management.

As we will see in the example below, the intuition developed above in sections 2.3.3 and 2.4.3 can carry through to this case. Firms with low net worth \( (A) \) are more likely to use bank monitoring because of decreasing returns to scale in investment, while firms with high liquidation value \( \tau \) face lower liquidity risk and are more likely to use credit lines. In addition, if low \( A \) firms also have high liquidity risk (low \( \tau \)), then we obtain the result that low \( A - \tau \) firms choose cash and bank financing \( (U_b^C) \), while high \( A - \tau \) firms choose credit lines and market (non-bank) financing.
2.6  Introducing heterogeneity in credit quality

The empirical literature shows that credit quality is an important determinant of the choice between cash and credit lines. Profitable firms, firms with low cash flow variance and high credit ratings are more likely to use credit lines for their liquidity management (Sufi, 2009), and shocks that increase liquidity risk cause firms to switch from credit lines to cash (Acharya et al, 2014). In contrast, firms with low credit-quality (e.g., unrated firms) tend to be bank-dependent for financing, but to rely on cash for liquidity management. In our model, this result arises from the observation that low credit-quality firms face stronger financing constraints (which increases the benefit of bank monitoring), and also greater liquidity risk (increasing the benefit of cash holdings vis a vis credit lines).

We now introduce a numerical example that characterizes the choice between cash and credit lines for low and high credit-quality firms.

2.6.1 Numerical example

Assume that the production function is represented by:

\[ R(I) = k \ln(I), \]

where \( k = 10 \). We also assume that \( p_H = 0.8, p_L = 0.4, B = 1.2, \rho = 1.2 \) and \( \lambda = 0.5 \). The cost of monitoring \( c \) is 0.05, while \( b = 1 \). Liquidity management frictions are represented by \( q = 1.05, \mu = 0.2 \) and \( \bar{w} = 3 \).

The high credit-quality firm has high net worth (\( A_{high} = 5 \)), and high liquidation value (\( \tau_{high} = 1 \)). The low credit-quality firm has \( A_{low} = 4 \), and \( \tau_{low} = 0.5 \).

In this setting, the first best investment level and payoff (which are the same for both types of firm) are given by:

\[
I^{FB} = \frac{p_H k}{1 + \lambda \rho} = 5 \tag{41}
\]
\[
U^{FB} = 4.88.
\]

The second best investment level and payoff are a function of net worth (high net worth firms

\textsuperscript{11}This calibration exercise is only for illustrative purposes. We do not seek to match real world quantities.
face lower underinvestment). We use equations 6, 7 and 10 to obtain:\footnote{In this example, the payoff when firms liquidate in state $\lambda$ is lower than $U^*$ for both firms so $U^*$ represents the second best.}

$$I_{SB}^{high} = 4.04, U_{SB}^{high} = 4.71, l_{SB}^{high} = 3.38$$
$$I_{SB}^{low} = 3.51, U_{SB}^{low} = 4.43, l_{SB}^{low} = 2.59. \tag{42}$$

High-quality firms invest at higher levels and achieve a greater payoff.

Let us now introduce the liquidity management frictions. To find the cash solution, we compute the effect of the liquidity premium on investments and payoffs. The liquidity premium reduces the firms’ total and marginal payoffs, and also tightens their financial constraints. Because of these effects investments and payoffs decrease for both types of firms. Using equations 16 and 60 we find:

$$I_{c}^{high} = 3.96, U_{c}^{high} = 4.51, c_{high} = 3.25$$
$$I_{c}^{low} = 3.44, U_{c}^{low} = 4.25, c_{low} = 2.50. \tag{43}$$

To find the credit line solution, we use equations 19, 20 and 61. In this solution firms will typically demand both credit lines and cash, unless total liquidity demand is lower than $\overline{w} = 3$:

$$I_{LC}^{high} = 4.421, U_{LC}^{high} = 4.55, \overline{w}_{high} = 3, c_{high}^{w} = 1.02 \tag{44}$$
$$I_{LC}^{low} = 3.78, U_{LC}^{low} = 4.17, \overline{w}_{low} = 2.97, c_{low}^{w} = 0.$$

Credit line revocation increases pledgeability, and thus the firm’s investment increases relative to the cash solution, for both types of firms. But the payoff can be higher or lower than the cash solution, because revocation is costly. In this example, the high quality firm benefits from using credit lines ($U_{LC}^{high} > U_{c}^{high}$), but the low quality firm does not ($U_{c}^{low} > U_{LC}^{low}$). This effect comes about due to higher liquidation costs for low quality firms ($\tau_{low} < \tau_{high}$). High quality firms can increase investment to $I_{LC}^{high} = 4.42$, and they demand a credit line equal to $\overline{w}$, and additional cash to meet liquidity needs ($c_{high}^{w} = 1.02$).

We now consider whether bank monitoring, and the associated increase in pledgeable income will benefit the two types of firms or not. As explained above, bank monitoring will increase pledgeable income and the feasible investment level, but will increase the effective cost of investment because of monitoring costs. For the high credit quality firm we have:

$$I_{b,high}^{LC} = 4.78, U_{b,high}^{LC} = 4.49. \tag{45}$$
Bank monitoring does allow this firm to increase investment, but leads to a reduction in payoff ($U_{b,high}^{LC} < U_{b,high}^{UC}$). In contrast, for the firm with low credit quality we have:

$$I_{c,low}^b = 4.22, \ U_{c,low}^b = 4.43, \ c_{b,low} = 2.40, \ i_{b,low}^{\max} = 0.21. \quad (46)$$

So, for this firm, the increase in investment that is associated with bank monitoring leads to an increase in payoff from $U_{c,low}^b$ to $U_{c,low}^b$. As explained above, the benefit of bank monitoring is highest for the firm with low credit quality, due to decreasing marginal returns of investment. Since low quality firms are more financially constrained, they benefit the most from bank monitoring. In equilibrium they invest $I_{c,low}^b = 4.22$, demand cash $c_{b,low} = 2.40$, and a bank loan equal to $i_{b,low}^{\max} = 0.21$.

We conclude that, as conjectured above, high credit-quality firms choose credit lines to manage liquidity risk, but do not rely on banks for their regular financing, while low credit-quality firms rely on banks for their financing but use cash to manage liquidity risk.

3 Equilibrium framework and the roles of bank capital and liquidity

Suppose now that the economy has a set of firms with measure one. Half of these firms have high credit quality ($A_{high}, \ \tau_{high}$), and the other half has low credit-quality ($A_{low}, \ \tau_{low}$).

At date-1, an aggregate state realizes, which determines whether firm liquidity shocks are idiosyncratic or aggregate in nature. The probability of aggregate liquidity shocks is $\theta$. In this case, a fraction $\lambda_\theta$ of firms face a liquidity shock. In state $(1 - \theta)$, a fraction $\lambda_{1-\theta}$ of the firms face a liquidity shock. This structure is identical for all firms. Thus, the unconditional probability of a liquidity shock ($\lambda$ in the model above) must obey:

$$\lambda = \theta \lambda_\theta + (1 - \theta) \lambda_{1-\theta}. \quad (47)$$

In this section we assume that $\lambda_\theta = 1$.

As in the model above, these firms can raise date-0 financing from a bank (monitored financing), or from arms-length individual investors, and can choose bank credit lines or cash for their liquidity management. The economy has a single bank that has initial capital $K_0$. This capital is available for lending at date 0. In addition, the bank has a contingent source of outside liquidity in state $\theta$, which it can use to honor credit line drawdowns in the bad aggregate state. Let the amount of contingent liquidity be denoted by $D_1$. This amount is in excess of the date-0 capital $K_0$. This outside liquidity can arise from the bank’s deposit-taking activities, as in Kashyap, Rajan, and
Stein (2002). The bank must hold excess cash to honor deposit drawdowns, and can use this cash to honor credit line drawdowns as well. Alternatively, contingent liquidity in a bad aggregate state can arise from the mechanism in Gatev and Strahan (2006), who show that cash may flow into the banking sector following negative aggregate shocks.

We also assume that the supply of contingent liquidity is risky. Specifically, there is a probability that $D_1$ will not be available to honor credit lines in state $\theta$. Let this probability be denoted by $\psi$. In the Kashyap, Rajan and Stein framework, this possibility arises from the observation that the bank may need to use its excess cash to honor deposit drawdowns, in which case the excess liquidity is not available to corporations. In state $\theta \psi$, a firm that relies on credit lines for liquidity management will not be able to withstand the liquidity shock. Thus, the probability of credit line revocation $\mu$ (conditional on the liquidity shock) is given by:

$$\mu = \frac{\theta \psi}{\lambda}.$$ (48)

Notice that since liquidity shocks are idiosyncratic in state $(1-\theta)$, the bank does not require outside liquidity to meet credit line drawdowns in that state (e.g., the corporate sector is self-sufficient). Irrespective of bank liquidity, there is no revocation in that state.

In state $\theta(1-\psi)$, the firm can rely on the credit line for liquidity management. However, aggregate credit line drawdowns must be lower than $D_1$. If the firms’ liquidity demand is greater than $D_1$, then firms must hold cash in addition to the credit line in order to meet the liquidity shock.

The liquidity premium $q$ is determined by the equilibrium in the date-0 market for cash. The demand for cash will depend on firms’ optimal liquidity management policies. Denote the aggregate demand for cash by $C(q^*)$. We assume that there is an exogenous supply $C_s(q)$ of liquid assets, with $C'_s(.) \geq 0$.

### 3.1 Optimal allocation of capital and liquidity by the bank

The bank can decide whether to use capital and contingent liquidity to support date-0 loans, or date-1 credit line drawdowns. For example, it can save some of its capital as cash, and use cash to support future credit line drawdowns. Or it can raise financing against its excess date-1 liquidity to increase date-0 loans.

Because the bank must also pay the liquidity premium to hold cash until date-1, in this version of the model there is no motivation for the bank to save date-0 capital as cash. Such a solution is exactly equivalent to one in which the money is lent to the firm at date-0 and the firm saves the
cash in its balance sheet. In either case, the firm will have to pay the liquidity premium (either directly or through credit line fees). We assume that in such a case, firms borrow at date-0 and hold cash internally.

However, the bank may decide to raise financing against date-1 liquidity to make more loans at date-0. This can happen when initial capital $K_0$ is not sufficient to finance the loan amount $i_b^{\text{max}}$ for all firms that demand bank-monitored financing. In such a case, we must characterize the bank’s choice between date-0 lending and date-1 credit line drawdowns (see below). Denote the bank’s optimal loan amount by $i_b^*$ (and the aggregate amount by $I_b^*$). In addition denote the bank’s optimal amount of aggregate credit line provision by $W_1^*$.

We assume that the bank’s choice of loan and liquidity provision maximizes the aggregate payoff in the economy. Denoting optimal firm choices by $U_{\text{low}}^*, U_{\text{high}}^*$ for firms of low and high credit quality, we have:

$$\{W_1^*, I_b^*\} = \arg\max \frac{1}{2} U_{\text{low}}^*(I_b, D_1) + \frac{1}{2} U_{\text{high}}^*(I_b, D_1).$$  \hspace{1cm} (49)

### 3.2 Definition of equilibrium

An equilibrium in this framework is such that:

- Firms of both types pick the highest payoff from the set $\{U^{LC}, U^c, U_b^{LC}, U_b^c\}$, given the bank’s optimal choice of lending and credit line provision $\{W_1^*, I_b^*\}$, and the liquidity premium $q^*$.

- The bank’s optimal choice of lending and credit line provision is $\{W_1^*, I_b^*\}$ in equation 49, given the liquidity premium $q^*$, firms’ optimal choices $U_{\text{low}}^*$ and $U_{\text{high}}^*$, and bank capital and liquidity, $K_0$ and $D_1$.

- The market for liquid assets clears, that is, at the equilibrium price $q^*$ the aggregate demand for liquid assets $C(q^*)$ that is associated with the optimal choices $\{W_1^*, I_b^*\}$, $U_{\text{low}}^*$ and $U_{\text{high}}^*$ is lower or equal to supply $C_s(q^*)$.

### 3.3 Examples

We now illustrate the determination of equilibrium with some examples.

#### 3.3.1 Excess bank capital

First, consider a case in which bank capital $K_0$ is large enough, such that date-0 lending is not constrained by the availability of capital. This assumption means that the bank uses capital for
date-0 lending, and contingent liquidity $D_1$ to support credit line drawdowns in the bad aggregate state ($W_1^* = D_1$, $I_b^* = I_b^{\text{max}}$).

Assume as above that low quality firms choose bank lending and cash ($U_{\text{low}}^* = U_{\text{b,low}}^c$), and high quality firms choose market financing and credit lines ($U_{\text{high}}^* = U_{\text{LC,high}}^L$). We now derive the conditions that are required for this choice to be an equilibrium one.

First, cash demand by low quality firms is given by $\rho I - \rho_0^b(I)$, where investment is $I = I_{\text{b,low}}^c$, which is a function of the cost of liquidity $q$ (equation 36). The demand for credit lines by firms that rely on credit lines is given by $c_w(I) = \rho I - \rho_0(I) - \bar{w}$, where investment is $I = I_{\text{LC,high}}^L$ (equation 20). Thus, the aggregate demand for cash is given by:

$$C(q) = \frac{1}{2}[\rho I_{\text{b,low}}^c - \rho_0^b(I_{\text{b,low}}^c)] + \frac{1}{2}[\rho I_{\text{LC,high}}^L - \rho_0(I_{\text{LC,high}}^L) - \bar{w}].$$

Equilibrium requires that, at the equilibrium price $q^*$, $C(q^*) = C_s(q^*)$. The equilibrium price must be greater than one, or high quality firms would also prefer to use cash for liquidity management. The aggregate demand for credit line drawdowns is given by $\frac{1}{2}\bar{w}$, which must be equal to the supply of contingent liquidity in this case:

$$\frac{1}{2}\bar{w} = D_1$$

Finally, equilibrium requires that firms’ choices are indeed optimal given the equilibrium cost of liquidity $q^*$. In particular, low quality firms do not benefit from switching to non-bank date-0 financing, nor to credit lines. High quality firms do not benefit from switching to bank financing, nor to cash.

Starting from such an equilibrium, a small shock to bank capital $K_0$ will not change the equilibrium (since there is excess bank capital already). In particular, as we discuss above, the bank cannot use bank capital to improve liquidity management in the bad aggregate state relative to the situation in which firms save cash themselves.

In contrast, a change in future bank liquidity ($D_1$) does affect the equilibrium, as it reduces credit line availability to high quality firms ($\bar{w}$ goes down), and increases their demand for cash ($c_w(I)$ goes up). We will characterize the impact of such a shock below.

**Numerical example** We now introduce a numerical example to illustrate the equilibrium and perform some comparative statics. We follow the example in Section 2.6.1, in which low quality firms choose cash and bank monitoring and high quality firms choose credit lines and market financing, and show how this choice can be supported by an equilibrium with excess bank capital.
**Equilibrium**  First, let $\theta = 0.2$, and $\lambda_{1-\theta} = 0.375$. This means that $\lambda = \theta + (1 - \theta)\lambda_0 = 0.5$, as in the example.

Second, bank capital $K_0$ must be larger than the required date-0 bank financing, $L^{\text{max}}$, which is $0.5 \times 0.21 = 0.105$ in the example. Take for example $K_0 = 0.2$.

Third, we must have $D_1 = \frac{1}{2}w = 1.5$.

Fourth, since $\mu = \frac{\theta_0}{\lambda}$, we must have $\psi = \frac{\lambda_0}{\theta} = 0.5$.

Fifth, the equilibrium liquidity premium must be equal to $q^* - 1 = 0.05$, given that aggregate cash demand is $C(q) = \frac{1}{2}[\rho I^{LC}_{b,low} - \rho_0(I^{LC}_{b,low})] + \frac{1}{2}[\rho I^{LC}_{high} - \rho_0(I^{LC}_{high}) - \bar{w}] = 1.7$. For now, we assume that the supply of liquid assets is perfectly elastic, so that the liquidity premium stays constant at $0.05$.

Thus, these parameters ($\theta = 0.2$, $\lambda_{1-\theta} = 0.375$, $\psi = 0.5$, $D_1 = 1.5$, $K_0 = 0.2$, and perfectly elastic $C_s(q)$) together with the parameters in Section 2.6.1 generate an equilibrium in which firms make the choices characterized in that Section. The analysis in Section 2.6.1 already show that firms do not have incentives to deviate from these choices given the equilibrium premium $q^* - 1$ and bank actions (which we took as given in that Section’s analysis).

**Comparative statics**  Consider now the impact of a reduction on $D_1$ in this equilibrium. Specifically, suppose that $D_1$ goes to $1.35$ so that the maximum credit line available to high quality firms ($\bar{w}$) decreases to $2.7$.

First, notice that low quality firms will be unaffected by this shock since they rely on cash for liquidity management, and the liquidity premium will remain constant at $q - 1 = 0.05$ given the assumption of perfectly elastic supply.

Equilibrium investment by high quality firms is given by equation 20 above:

$$A_{\text{high}} + (1 - \lambda \mu)\rho_0(I^{LC}_{\text{high}}) + \lambda \mu \tau_{\text{high}}I^{LC}_{\text{high}} = (1 + \lambda(1 - \mu)\rho)I^{LC}_{\text{high}} + (q - 1)c_w(I^{LC}_{\text{high}}).$$

(52)

For a given investment level, the negative shock to credit line availability forces high quality firms to hold more cash since $c_w(I^{LC}_{\text{high}}) = \rho I^{LC}_{\text{high}} - \rho_0(I^{LC}_{\text{high}}) - \bar{w}$. Since holding cash is costly ($q - 1 > 0$), equilibrium investment by high quality firms decrease. In this example, $I^{LC}_{\text{high}}$ goes down from 4.421 to 4.414 (a decrease of 0.16%). In addition, cash holdings by high quality firms ($c^{\text{w}}_{\text{high}}$) go up from 1.02 to 1.31.

This negative shock to bank liquidity also decreases high quality firms’ payoff of using credit lines. At some point, this effect can cause high quality firms to abandon bank credit lines and move into cash-based liquidity management. In our example this happens when $D_1$ goes to 1.05. High
quality firms switch into cash, which causes a large decrease in investment and a large increase in cash holdings ($I_{high}^c = 3.96$, and $c_{high} = 3.25$). This effect represents a 10.34% decrease in investment relative to the baseline case of $D_1 = 1.5$.

Finally, notice that if $D_1$ falls below 1.05, high-quality firm investment remains constant at $I_{high}^c = 3.96$ since the firm is no longer relying on credit lines at this point.

### 3.3.2 Limited bank capital

This case obtains when $I_b^{\text{max}} > K_0$, so that the bank does not have sufficient date-0 capital to make all required loans to firms that require bank monitoring (the low quality firms in our example). In such a case, the bank can increase the loan made to low quality firms ($I_b^*$), by raising date-0 funds from date-1 contingent liquidity. Since contingent liquidity is available in state $\theta(1 - \psi)$, the bank can raise up to $\theta(1 - \psi)D_1$ in date-0 funds from date-1 contingent liquidity.

This reallocation of date-1 liquidity into date-0 loans will generally be optimal for the bank, because the effect of an increase in $I_b^*$ on the payoff of low-quality firms is larger than the effect of an increase in $W_1^*$ on the payoff of high-quality firms. This result arises from a combination of two effects:

First, an increase in $I_b^*$ has a direct effect on the investment level of low quality firms since $I_{low,b}^c$ is given by:

$$
(1 + \lambda \rho)I_{low,b}^c + (q - 1)c_{low,b}(I_{low,b}^c) = A + \rho_0^b(I_{low,b}^c) + \overline{ib}.
$$

$I_b^*$ has a direct impact on $\overline{ib}$, which relaxes the financing constraint for low quality firms. In contrast, the increase in $W_1^*$ only affects optimal investment by high-quality firms indirectly, by reducing the cost of cash holdings (see equation 52 above).

Second, low-quality firms invest at lower levels in equilibrium ($I_{low,b}^c < I_{low,b}^{LC}$) and thus their marginal productivity of investment is larger than that of high-quality firms.

The numerical example below shows this effect at work.

**Numerical example** To give a specific example, assume that $D_1 = 1.5$ as in the baseline example, but that $K_0 = 0.05$.

Suppose initially that the bank decides to allocate all of contingent liquidity $W_1$ to credit lines ($W_1^* = D_1$). This means that the maximum loan to low quality firms is $K_0 \times 2 = \overline{ib} = 0.1$. Following the analysis of Section 2.4.2, for the case in which the low quality firm uses cash for liquidity management (Section 2.5), we find that investment and payoff decrease for the low quality firm.
firm. As above, the maximum possible levels (which obtain when $I_b^* = I_b^{\text{max}}$) are given by:

$$I_{b,\text{low}}^c = 4.22, \quad U_{b,\text{low}}^c = 4.43.$$  \hfill (54)

In addition, when $D_1 = 1.5$, the investment and payoff for high-quality firms is computed above:

$$I_{\text{high}}^L = 4.421, \quad U_{\text{high}}^L = 4.55$$  \hfill (55)

In contrast, the solution when $I_b^* = K_0 = 0.05$ is:

$$I_{b,\text{low}}^c = 4.16, \quad U_{b,\text{low}}^c = 4.32.$$  \hfill (56)

In our example, $\theta(1 - \psi)D_1 = 0.15$, so the bank can raise sufficient funds to increase date-0 loans up to $i_{b}^{\text{max}} = 0.21$. Consider the outcome in this case:

This requires:

$$K_0 + \theta(1 - \psi)(D_1 - W_1^*) = 0.5i_{b}^{\text{max}} = 0.105,$$  \hfill (57)

so that the optimal amount of liquidity allocated to date-1 credit line provision would be $W_1^* = 0.95$. The bank allocates 0.55 of date-1 liquidity to date-0 loans. This effect decreases investment and payoff for high quality firms, as calculated above:

$$I_{\text{high}}^c = 3.96, \quad U_{\text{high}}^c = 4.51.$$  \hfill (58)

Recall that the high-quality firm also relies on cash if $W_1^* < 1.05$.

Thus, if the bank allocates date-1 liquidity to increase date-0 loans, the payoff for low quality firms goes from $U_{b,\text{low}}^c = 4.32$ to $U_{b,\text{low}}^c = 4.43$, while the payoff for high quality firms decreases from $U_{\text{high}}^L = 4.55$ to $U_{\text{high}}^c = 4.51$. The increase in the payoff of low-quality firms is significantly greater than the decrease in the payoff of high quality firms. Thus, by equation 49, equilibrium bank actions when $K_0 = 0.05$ are $W_1^* < D_1$, and $I_b^* = I_b^{\text{max}}$.

### 3.4 Summary

If bank capital is large enough, lower bank liquidity decreases investment and increases cash held by high quality firms. The effect of bank liquidity on investment is particularly strong when it causes high quality firms to stop relying on credit lines. In the example above the liquidity premium is constant, so low quality firms are not affected by bank liquidity shocks. If the liquidity premium increases with the demand for cash, then the shock will transmit to low quality firms. In this case, low quality firms are less affected than high quality firms, particularly so if the supply of
liquidity is highly elastic.

If bank capital is low enough to constrain the equilibrium, then the bank has incentives to use its liquidity to increase loans to low quality firms. Banks allocate liquidity first to loans and only then to liquidity provision. If there is enough liquidity to make all necessary date-0 loans, then shocks to bank capital (or liquidity) affect mostly credit line provision, and high quality firms. The potential impact of the shock on low quality firms gets absorbed by the transformation of date-1 liquidity into date-0 loans.

If capital is low, and liquidity is not sufficient to increase date-0 loans to the optimal amount, then it must be that high quality firms no longer rely on credit lines (because the bank uses liquidity to make loans). Starting from such equilibria, low quality firms will be sensitive to shocks to bank capital, while high quality firms are unaffected by shocks to the banking system because they no longer rely on banks. Negative shocks to bank capital decrease low-quality firms’ investment (as in Holmstrom and Tirole, 1997), and also cash holdings.

3.5 Contamination effects on low quality firms

In the model above, if we start from an equilibrium in which high credit quality firms rely on credit lines from liquidity insurance (which is consistent with the empirical evidence), a negative shock to bank health will mostly affect high quality firms. However, as we now show, there can be important contamination effects that stem from the behavior of high quality firms.

In order to show this effect in the simplest possible way, we modify the model as follows. First, we introduce an additional date such that the economy now has 4 dates. We also introduce an additional asymmetry across high, and low credit quality firms. High credit quality firms invest in date-0, and obtain a return in date-3. Low credit quality firms, only invest in date-1, obtaining a return in date-3. In addition, low credit quality firms are no longer subject to liquidity shocks (which happen at date-2).

As in the model above, the value of $\lambda$ is revealed in date-1, when an aggregate state realizes and determines whether firm liquidity shocks in date-2 are idiosyncratic or aggregate in nature. However, we now allow the high quality firms that rely on credit lines to drawdown their credit lines in date-1. In this case, the cash generated from their drawdown is kept until date-2 to meet the liquidity requirements in date-2, by holding liquid assets that sell at a date-1 price $q_1 > 1$. This price is lower than the date-0 price, $q_0 \geq q_1$, so that securing liquidity at date-0 is more expensive than at date-1.

Effectively, high quality firms move from credit lines into cash if they do so. Naturally, the
incentive to drawdown their existing credit lines will be stronger when there is an aggregate liquidity shock \((\lambda = \lambda_\theta)\), as this will affect the probability that credit lines will be revoked in date-2 (the probability \(\mu\) is higher on the aggregate state \(\lambda_\theta\)).

The option to draw down in date-1 means that cash implementation is dominated by credit line implementation with date-1 drawdown, which ensures full insurance but at a lower cost in terms of incurred liquidity premium than the cash implementation \((q_0 \geq q_1)\). High credit quality firms thus always choose credit lines for their liquidity management, and their decision is limited to the size of the credit line, and whether to access the credit line in date-1 and keep cash until date-1 (a "run" on existing credit lines), or wait until date-2 to draw on credit lines.

Let us start by taking the date-0 size of the credit line as exogenous:

\[
\omega(I) = \omega
\]  

We take \(\omega\) as given, and analyze the date-1 credit line run decision next. Then we characterize the determination of the optimal date-0 credit line.

### 3.5.1 Credit line run decision in date-1 in state \(\theta\)

In date-1, a high quality firm observes the realization of the aggregate state, which determines the values for \(\lambda\) and \(\mu\), and decides whether to access its credit line immediately, or wait until date-2. The probability of revocation in state \((1 - \theta)\) is denoted \(\mu_{1-\theta}\). Since liquidity shocks are idiosyncratic in this state, the bank will never run out of liquidity and thus \(\mu_{1-\theta} = 0\). Given this, firms will not run on their credit lines in state \((1 - \theta)\).

If the firm draws down its credit line in the aggregate state, its payoff is:

\[
U^{\text{run}} = p_H R(I) - \lambda_\theta \rho I - (q_1 - 1) \omega. \tag{60}
\]

The firm will continue the project in every state in date-2, and it will pay a liquidity premium \((q_1 - 1)\) on the amount drawn on the credit line, \(\omega\). Notice that in this case the probability of revocation \(\mu_{\theta}\) goes to zero since the firm accesses liquidity early at date-1.\(^{13}\)

If the firm does not draw down its credit line, its payoff is instead:

\[
U^{\text{LC}} = (1 - \lambda_\theta \mu_{\theta}) p_H R(I) + \lambda_\theta \mu_{\theta} \tau I - \lambda_\theta (1 - \mu_{\theta}) \rho I. \tag{61}
\]

The firm in this instance exposes itself to a credit line revocation with probability \(\lambda \mu\), and in those

\(^{13}\)We assume that the bank always has sufficient liquidity to meet early credit line drawdowns, as will be discussed later.
states liquidates its capital in return for \( \tau I \). The value of \( \mu_\theta \) in this case will depend on the financial health of the firm’s lender, as will be described later.

Firms choose to run on their credit line if \( U^{run} - U^{LC} \), given by

\[
U^{run} - U^{LC} = \lambda \theta \mu_\theta \left(p HR(I) - \rho I - \tau I\right) - (q_1 - 1)\bar{w},
\]

is bigger than 0. By choosing to run on the credit line, firms are able to continue the investment in state \( \lambda \theta \mu_\theta \), which is efficient given assumption (3). But this happens at the cost of incurring a liquidity premium on the cash carried between date-1 and date-2.

### 3.5.2 Optimal investment level of high quality firms in date-0

Firms in date-0 choose the size of their investment \( I \), and amount of cash holdings \( c_w(I) \), taking into account their optimal date-1 credit line run decision and \( \bar{w} \).

Consider first the case in which the firm anticipates to run on its credit line in state \( \theta (U^{run} - U^{LC} > 0) \). Given this condition, and since \( \mu_{1-\theta} = 0 \), the firm solves the following optimization problem in date-0:

\[
\max_I p HR(I) - \rho I - (q_0 - 1)c_w(I) - \theta(q_1 - 1)\bar{w}
\]

\[
\text{s.t. } A_{high} + \rho_0(I) \geq (1 + \rho)I + (q_0 - 1)c_w(I) + \theta(q_1 - 1)\bar{w}
\]

We assume that \( A_{high} \) is high enough for the budget constraint to be satisfied, so high credit quality firms’ optimal investment \( I_{high}^* \) will satisfy

\[
p HR'(I_{high, run}^*) = (1 + \rho) + (q_0 - 1)c_w(I_{high, run}^*),
\]

and the optimal amount of cash holdings will be \( c_w(I_{high, run}^*) \).

If the firm does not anticipate to run, then the optimal date-0 investment will depend on the probability of credit line revocation at date-2 (\( \mu_\theta \)). The solution is the same as the one we characterized above in Section 2.3.2, with \( \mu = \mu_\theta \), \( \lambda = \lambda_\theta \) and \( q = q_0 \). Denote the optimal investment by \( I_{high, no\ run}^* \).

### 3.5.3 Low credit quality firms

We assume that low quality firms find it optimal to rely on bank lending to raise financing at date-1 (as in the example discussed in Section 2.6.1). They do not face liquidity risk in date-2. The
amount of investment they will be able to make will depend on whether there is limited or excess bank capital, which in turn depends on the realization of the aggregate state and whether high credit quality firms decide to run on their credit lines in date-1. This is the main channel through which high credit quality firms’ liquidity management can contaminate the investment decisions of bank-dependent firms in the model.

The optimal investment of low quality firms is as characterized above (Section 2.4), setting the liquidity shock $\rho$ to zero. If bank capital is not a constraint, we have that $L^*_b = L^\text{max}_b$. The firm will solve the following problem under bank monitoring:

$$\max_{p_H} R(I) - I - \varphi I \quad \text{s.t.} \quad \varphi \left(\frac{p_H}{p_H - p_L} - 1\right) I$$

We denote the resulting interest rate on the loan as $\alpha$, which is given in this case by:

$$\alpha^{\min} = \frac{R_b}{L^\text{max}_b} - 1 = \frac{\varphi}{p_H - \varphi(p_H - p_L)} - 1.$$  \hspace{1cm} (66)

This case results in the maximum possible investment by low quality firms, $I^{\text{max}}_{\text{low}}$.

In the case of limited bank capital, denote the maximum loan that the bank can make by $L_b$. The firm’s problem becomes:

$$\max_{p_H} R(I) - I - \varphi I \quad \text{s.t.} \quad \varphi \left(\frac{p_H}{p_H - p_L} - 1\right) I$$

$$\leq A_{\text{low}} + \rho_0^b(I) + L_b$$

The resulting interest rate on the loan is

$$\alpha = \frac{R_b}{L_b} - 1 > \alpha^{\min}.$$  \hspace{1cm} (68)

In this case of limited bank capital, the optimal investment by low quality firms is an increasing function of $L_b$:

$$I^{*}_{\text{low}} = I(L_b).$$  \hspace{1cm} (69)

### 3.5.4 Equilibrium framework and the roles of bank capital and liquidity

Since the bank makes no loans at date-0, it will simply carry its capital from date-0 to date-1. Let date-1 bank capital be equal to $K_1$. As in the model above, the bank also has a contingent source of outside liquidity in state $\theta$ in date-2, which we denote here by $D_2$. The supply of contingent liquidity is risky as above. There is a probability $\psi$ that $D_2$ will not be available in state $\theta$ in date-2.
Date-1 capital is available for lending at date 1 to low credit quality firms \((L_b)\), and for lending at date 1 to high credit quality firms that draw down on their credit lines (denote this amount by \(L_{LC}\)). The rest is kept as liquidity \((W_1)\) to meet date-2 credit line drawdowns by high credit quality firms. The bank must also pay the liquidity premium \(q_1 > 1\) to hold cash until date-2, so saving \(q_1 W_1\) in date-1 generates an amount of cash \(W_1\) in date-2. The bank is also able to borrow in date-1 against date-2 liquidity, in which case \(W_1 < 0\). We assume the bank can borrow at the required gross rate of return of 1. The bank’s date-1 budget constraint is then

\[
K_1 = L_b + L_{LC} + q_1 W_1 \quad \text{if} \quad W_1 > 0, \quad \text{or} \quad \tag{70}
K_1 = L_b + L_{LC} + W_1 \quad \text{if} \quad W_1 \leq 0. \tag{71}
\]

The bank’s date-2 liquidity is:

\[
W_2 = W_1 + D_2 \quad \text{in state} \ 1 - \psi \tag{72}
= W_1 \quad \text{in state} \ \psi, \quad \text{if} \ W_1 > 0
= 0, \quad \text{in state} \ \psi, \quad \text{if} \ W_1 \leq 0.
\]

Notice that if the bank borrows against date-2 liquidity, it will default in state \(\psi\) so that \(W_2\) remains positive. Notice also that bank borrowing is constrained and we must have \(-W_1 \leq (1 - \psi) D_2\). We assume that the bank always has sufficient liquidity to make either the optimal amount of date-1 lending, or to meet early credit line drawdowns:

\[
K_1 + (1 - \psi) D_2 \geq \max(L_{b,1-\theta}^{\max}, W). \tag{73}
\]

3.5.5 Optimal date-1 allocation of capital and liquidity by the bank

As above, we assume that the bank chooses \(L_b\) and \(L_{LC}\) to maximize the aggregate payoff in the economy. These choices also imply a choice of \(W_1\) by the bank budget constraints given by (70), (71).

The bank’s optimal choice is conditional on the date-1 aggregate state. In the good aggregate state \((1 - \theta)\) the bank has no issue meeting credit line drawdowns in the future, and thus it maximizes date-1 lending to low quality firms. In addition, firms have no incentives to run on credit lines:

\[
L_{b,1-\theta}^* = L_{b,1-\theta}^{\max} \tag{74}
L_{LC,1-\theta}^* = 0.
\]

In state \(\theta\), the bank’s optimal decision will depend on whether high quality firms run on their
credit lines or not.

If high quality firms choose not to run, then the bank’s optimal actions are similar to what we characterized above (Section 3.4). If bank capital is sufficiently high \((K_1 \geq L_b^{\text{max}})\), then the bank does not need to employ date-2 liquidity to make additional date-1 loans \((W_1^* = \frac{K_1 - L_b^{\text{max}}}{q_1} > 0)\). The bank has date-2 liquidity equal to \(D_2 + \frac{K_1 - L_b^{\text{max}}}{q_1}\) in state \(1 - \psi\), and \(\frac{K_1 - L_b^{\text{max}}}{q_1}\) in state \(\psi\). If bank capital is lower \((K_1 < L_b^{\text{max}})\), then the bank will have incentives to borrow against date-2 liquidity to increase the provision of date-1 loans. This reduces date-2 bank liquidity \((W_2\) goes up), increasing the probability of revocation \(\mu_b\). This argument shows that the probability of revocation \(\mu_b\) is a function of bank capital and liquidity. We denote this key relationship by \(\mu_b(K_1, D_2)\), which is given by

\[
\mu_b(K_1, D_2) = \begin{cases} 
\psi - \frac{W_1}{D_2} = \psi - \frac{K_1 - L_b - L_{\text{LC}}}{D_2} & \text{if } W_1 < 0 \\
\psi & \text{if } W_1 \geq 0
\end{cases}
\] (75)

and takes values in the range \([\psi, 1]\). If the bank borrows as much as possible against date-2 liquidity so that \(W_1 = -(1 - \psi)D_2\), then the bank has no liquidity available in date-2 to satisfy credit line drawdowns and \(\mu_b(K_1, D_2) = 1\). In state \(\psi\), no firm has access a credit line. When \(\psi < \mu_b(K_1, D_2) < 1\), if there is some liquidity left that could satisfy some but not all credit lines, then there is a random sequential servicing such that in the same state in date-2 some firms are revoked and some others aren’t.

If high quality firms choose to run, then the bank is forced to make \(L_{\text{LC}} = \bar{w}\). The bank can then borrow against date-2 liquidity to help meet credit line drawdowns (date-2 liquidity is no longer needed if high quality firms run). By assumption 73, the bank will have sufficient date-1 funding to meet \(\bar{w}\), and uses the rest of its date-1 capital to make loans to low quality firms:

\[
L_{b,\text{run}}^* = K_1 + (1 - \psi)D_2 - \bar{w}.
\] (76)

The key result of this extension is that, if \(L_{b,\text{run}}^* < L_b^{\text{max}}\), then lending to low quality firms is contaminated by the provision of credit line insurance to high quality firms. This reduction in loan supply causes lower investment by low quality firms in date-1, by equation 69.

### 3.5.6 Equilibrium

An equilibrium in this framework has the following properties:

- In state \((1 - \theta)\), high quality firms never run and the bank maximizes lending to low quality firms \((L_{b,1-\theta}^* = L_b^{\text{max}})\), which invest \(L_{\text{low}}^{\text{max}}\).
• In state \( \theta \), there are two possibilities. If \( \mu_\theta(K_1, D_2) \) is low enough such that \( U^{\text{run}} - U^{\text{LC}} < 0 \), then high quality firms will choose not to run, and we obtain a no run equilibrium that is similar to what we characterized above (Section 3.4). If on the other hand \( \mu_\theta(K_1, D_2) \) is large enough that \( U^{\text{run}} - U^{\text{LC}} > 0 \), then it becomes optimal for high quality firms to run on their credit lines. Lending to low quality firms goes to \( L_{b,\text{run}}^* \).

• The date-0 choice of investment level \( I_{\text{high}}^* \) by high credit quality firms is consistent with their date-1 optimal credit line run decision as characterized in Section 3.5.2.

The key new result of this extension is the endogenous contamination effect that arises from the behavior of high quality firms. Suppose that we start from a no-run equilibrium \( (\mu_\theta(K_1, D_2) \text{ is low}) \). Negative shocks to \( K_1 \) or \( D_2 \) will directly affect firms, as characterized in Section 3.4. In addition to these direct effects, the model generates an additional amplification effect when \( \mu_\theta(K_1, D_2) \) becomes high enough that high quality firms decide to run on their credit lines. This run will further dry up bank capital, and reduce lending to, and investment by low quality firms.

3.5.7 Numerical Solution

To illustrate the contamination effect that arises from the behavior of high quality firms, we introduce a numerical solution for the date-1 equilibrium in state \( \theta \), and study how the equilibrium changes with variations in the amount of bank capital \( K_1 \).

**Figure 1 About Here**

We assume that high and low quality firms have access to the same production function represented by:

\[
R(I) = k \ln(I),
\]

where \( k = 8 \). We also assume that for both types of firms \( p_H = 0.8 \) and \( p_L = 0.4 \). For low quality firms we set \( B = 1.2 \), cost of monitoring \( \varphi \) is 0.5, and \( b = 0.5 \). Liquidity management frictions for high credit quality firms are represented by \( q_0 = 1.15, q_1 = 1.13, \rho = 1.2, \lambda_\theta = 0.75, \tau = 0.8 \) and \( \overline{w} = 1.2 \). For simplicify, we ignore the date-0 investment decision of high quality firms and assume that \( I_{\text{high}}^* = 5 \). The probability \( \psi \) that \( D_2 \) will not be available in state date-2 is set at 20\%, and \( D_2 = 0.9 \) so that the bank is able to satisfy all drawdowns \( \lambda_\theta \overline{w} \) in state \( (1 - \psi) \). Our parameter choices ensure that the bank in state \( \theta \) in date-1 always prefers to lend to low credit quality firms than to save liquidity for date-2 drawdowns. This means that whenever bank capital \( K_1 \) is below
$L_{b,max}$, the bank borrows against date-2 liquidity until $L_b = L_{b,max}$, subject to the constraint that $-W_1 \leq (1 - \psi)D_2$.\(^{14}\)

The range of bank capital values considered in the comparative statics is $K_1 \in [1.2, 2.1]$, and the results are displayed in Figure 1. When bank capital is large enough ($K_1 \geq 1.93$) so that the second best investment level of low quality firms $I_{low}^{\text{max}} = 3.85$ can be sustained without borrowing against date-2 liquidity, then the bank saves its residual capital and $W_1 > 0$. When its capital is large but not enough to implement $L_b^{\text{max}} = 1.93$, it can borrow against its date-2 liquidity $D_2$ and still lend to low quality firms at that level. The consequence of borrowing against date-2 liquidity is that the probability of revocation of the credit lines of high quality firms increases. Beyond a certain point, high quality firms might find it optimal to draw down on their credit lines in date-1 and ensure the availability of liquidity to face their date-2 investment shock. In the current calibration, this threshold is reached when the probability of revocation is $\mu_\theta = 0.685$, which corresponds to capital $K_1=1.49$. Below this level of bank capital, high quality firms run on their credit lines, which consumes a large part of the capital available for lending to low quality firms. The bank finds it optimal to fully borrow against date-2 liquidity, but this is not enough to prevent a large fall in lending to low quality firms, which goes down to $L_b = 1.00$ when $K_1=1.49$, and decreases with further decreases in $K_1$. This large reduction in bank lending to small firms illustrates the important contamination effects that can arise when a negative shock to bank health interacts with the behavior of high quality firms.

4 Empirical implications

Our framework generates four empirical implications, which we list here:

- **Cross-section of bank dependence**: in equilibrium, firms with high credit quality rely on banks for their liquidity insurance, but rely on markets (e.g., bonds) for their regular financing. Low credit quality firms rely on banks for their regular financing, but they rely on cash for liquidity insurance.

- **Ex-post effect of shocks to bank health on high quality firms**: starting from this equilibrium, a negative shock to bank capital or bank liquidity increases the probability that the bank revokes access to the credit line, for firms that rely on credit lines for insurance, and which face a liquidity shock of their own (e.g., they need to drawdown their existing credit lines).

\(^{14}\)This calibration exercise is only for illustrative purposes. We do not seek to match real world quantities.
• **Ex-ante effect of shocks to bank health on high quality firms:** starting from the equilibrium above, a negative shock to bank capital or bank liquidity causes high credit quality firms to substitute credit lines for cash in their liquidity management. This effect happens for firms that rely on credit lines for insurance, and which do not face a contemporaneous liquidity shock of their own. These firms do not need to drawdown their existing credit lines, but may do so to increase their cash reserves.

• **Contamination effects on low credit quality firms:** the substitution of credit lines for cash by high quality firms (ex-ante effect) further decreases bank liquidity, and transmits to low credit quality firms through a decline in bank lending.

5 **Data**

5.1 **Credit Line Covenants, Violations and their Consequences**

We collect data on credit line covenant violations and the responses of banks granting the credit lines to the violations for U.S. stock exchange listed firms between 2002 and 2011, and we do so using a detailed text search algorithm. To obtain the data we focus on firms’ filings with the Securities and Exchange Commission (SEC), and focus on annual filings (10-K filings), given that our firm balance sheet data is annual. In these filings firms are required to disclose the event of a covenant violation and also to discuss the actual or likely consequences. More specifically, the SEC Interpretive Release No. 33-8350 establishes that "...companies that are, or are reasonably likely to be, in breach of such covenants must disclose material information about that breach and analyze the impact on the company if material..." and that "...companies should consider the impact of debt covenants on their ability to undertake additional debt or equity financing." Unfortunately, the SEC does not require firms to disclose why they are in violation of covenants, and even though firms occasionally report which specific covenants they have violated, there could be important biases in the reporting of this variable, so we choose not to record that information.

The information we collect is the violation of a covenant attached to a line of credit, and the precise consequence of that violation.15 A credit line in breach of a covenant violation can generate three broad types of responses from banks. It can be **fully waived**, so that there is absolutely no consequence for the borrower and the credit line contract preserves its original terms and conditions,

15Nini, Smith, and Sufi (2010) conduct a similar text search that produces a dummy variable indicating the occurrence of a covenant violation. They do so for any type of debt contract and cannot specify if it is associated to a bond, a term loan, a line of credit, or any other type of debt contract. Our database differs from theirs in that we specifically collect credit line covenant violations, in that we also collect detailed information about the consequence for the firm of the violation, and in that we cover the recent financial crisis.
it can be *fully cancelled*, in which case the firm is explicitly restricted from any further access to funds under that line of credit, or it can suffer one or more of a number of alterations to the existing terms and conditions of the credit line contract.\(^{16}\) We classify these consequences into five categories. *Interest rate increases* happen if the bank reacts by raising the spread over the reference rate on borrowings under the line of credit. A bank can reduce the limit on the line of credit partially without fully revoking the line, and we record this event as a *partial revocation*. It can also adjust the existing covenants to make them stricter, or introduce new ones, resulting in a *covenant tightening*. The response might involve raising the borrowing base requirements, by which a firm can only borrow up to a fraction of the value of certain assets, typically receivables and inventories, or pledging more assets or cash, or requiring capital injections. We record all of these as *asset pledge requirements*. Finally, there might be a *maturity shortening* of the line of credit or of the drawn amounts. We create a residual category, *other*, which includes cases in which the firm is still waiting for a decision from the bank, which could also involve a negotiation between the firm and the bank, and responses which cannot be categorized in any of these buckets. A detailed description of the text search algorithm is provided in the appendix.

Given that covenant violations can be anticipated, it is plausible that the firm and the bank might engage in a renegotiation of contract terms prior to a violation. This is strongly supported by evidence in Roberts and Sufi (2009) who show that only 18% of renegotiations in debt contracts occur following a covenant violation. For this purpose, we also collect all of the above events irrespective of whether there has been a violation. More specifically, we search for any instance in which the terms of a line of credit have been renegotiated with *negative* results for the borrower. We ignore renegotiations that lead to improvements in conditions, as one would expect that the approach of a violation would be unlikely to generate such a result.\(^{17}\) Of course, the only consequence which we do not record here are waivers, as they cannot occur outside of a formal covenant violation.

Credit line contracts can feature many types of covenants, including financial covenants, dividend restrictions, and prepayment requirements (sweeps). Financial covenants are restrictions on the level of specific accounting variables, and we collect data on the types of financial covenants

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\(^{16}\)From a legal point of view, any consequence of a covenant violation that is not a full cancellation of the line of credit can be considered a 'waiver' because the bank does not make use of its right to revoke the line. In our classification we consider as *full waivers* those cases in which there has been no reaction at all from the bank, and we will introduce a definition of *waiver* in Section 3 distinct from the legal concept.

\(^{17}\)There is one exception, and that is that a bank may relax a covenant when it anticipates a firm might violate it in the future, when that firm has a high creditworthiness, in the context of relationship lending. To the extent that this is a frequent event, our estimates of waiver frequencies (broadly understood to include waivers in anticipation of violations) would be slightly biased downwards.
credit line contracts feature for the firms of our sample from the Loan Pricing Corporation (LPC)’s Dealscan database, a database which is described in more detail in section 5.3. Unfortunately, our covenant violation database cannot capture which covenants are being violated because firms are not obliged to disclose this information in their 10-K filings.

5.2 Firm-level data

We obtain firm-level data from the Capital IQ (CIQ) and Compustat databases for the period of 2002-2011. We restrict ourselves to U.S. firms covered on both databases and traded on AMEX, NASDAQ, or NYSE. We remove utilities (SIC codes 4900-4999) and financial firms (SIC codes 6000-6999). We remove firm-years with negative revenues, and negative or missing assets, obtaining in the end a sample of 32,481 firm-years involving 4,741 unique firms.

CIQ compiles detailed information on capital structure and debt structure by going through financial footnotes contained in firms’ 10-K Securities and Exchange Commission (SEC) filings. Most importantly for our purposes, firms provide detailed information on the drawn and undrawn portions of their credit lines in the liquidity and capital resources section under the management discussion, or in the financial footnotes explaining debt obligations, and CIQ compiles this data. 10-K filings typically also contain information on pricing and maturity of credit lines, but this data is not collected by CIQ. Following Sufi (2009) we construct a measure of the amount of credit lines expressed as a percentage of net book assets (Compustat item 6 - item 1). We compute the ratio of cash and investments (item 1) over total book net assets (item 6 - item 1). Following standard procedures, all variables are winsorized at the 0.5% in both tails of the distribution.

5.3 Firm-Lender Relationships and Bank Financial Health Data

We obtain data for firm-lender relationships and exposures from the Loan Pricing Corporation (LPC)’s Dealscan database. Our extract of the database contains detailed information on loans made by financial institutions (including commercial banks, investment banks, insurance companies and pension funds) to U.S. corporations during the period 1981 to 2011. Most of the loans captured by Dealscan are syndicated, although there are some sole-lender loans as well. Importantly, LPC identifies all of the lenders in each syndicate. LPC collects its data from multiple types of SEC filings, from media releases, and from direct contact with borrowers and lenders. It is important to note that due to data limitations we cannot observe which bank is calling the covenant violation, which means that whenever we relate firm-bank relationship or exposure measures we are doing it with some noise and under certain assumptions.
The share of all corporate lending in the U.S. covered by LPC is large, although clearly biased towards larger loans. Carey and Hrycay (1999) estimated that Dealscan covered between 50% and 75% of the value of all commercial loans in the U.S. during the early 1990s, and Chava and Roberts (2008) suggest that this share has been increasing over time.

For the purpose of addressing the question of how bank financial health affects covenant violation outcomes, we need to provide a measure of a firm’s exposure to different banks weighted by the amount of lending originated by each bank to that firm in recent years, which should capture with a high degree of precision the identity and weight of the lenders of the currently outstanding bank loans a firm has in its balance sheet. LPC Dealscan reports the lending allocations for banks in a syndicate, but only does so for around a third of observations. We thus estimate a simple model of bank allocations that only depends on (i) the status of the bank as lead lender or participant, (ii) the number of lead banks, and (iii) the number of participant banks. We consider a lender to be a lead lender when its role contains any of the following terms: "agent", "arranger", "lead" or "manager". Otherwise the bank is a participant. Once we have estimated the model, and for consistency, we apply the estimates to all observations, including the ones for which we had data.\textsuperscript{18}

Next, we calculate for each firm and year the share that each bank has in all of the lending done in the previous 5 years (not including the current year), and this share is calculated using the estimated allocations and the total loan amounts. If we cannot find the relevant financial health indicator for the bank, we substitute it by its nearest parent bank with available data. If we cannot find a parent bank with available data, we eliminate that bank and adjust, for each firm-year, the shares of the other banks proportionally so that they add up to 100%.

The exposure of each firm to its lenders’ financial health is calculated the average financial health ratio of the banks with which a firm has borrowed from in the previous 5 years, weighted by the share lent by each bank during those years. More specifically, we multiply the exposure variable times the financial health of the bank, to construct a firm-year variable that captures the weighted average health of the banks a firm is borrowing from. We extract bank financial information from the quarterly FFIEC Call Reports, which all regulated U.S. commercial banks are required to file, and also directly from the filings of foreign banks. In the case of the U.S., because some banks are owned by a common holding company, we aggregate the bank-level data for banks with common ownership by summing Call Report data at the holding company level for multibank holding companies (see Cornetta, McNutt, Strahan, and Tehranian (2011)).

\textsuperscript{18}The model fit in the sample for which we do have lending allocations is good. The correlation between estimated and actual allocations is 0.95 and highly significant, and the \( R^2 \) of a regression explaining the allocation of lead lenders using the variables we use (number of leads and number of participant banks) is 34%.
bank level financial health proxies and controls are constructed as follows. The Bank Deposit Ratio is calculated as Total Deposits (Call Report item RCFD2200) over Total Assets (RCFD2170). The Bank Liquidity Ratio variable is calculated as liquid assets (cash (RCFD0010), federal funds sold (RCONB987 + RCFDB989), and securities excluding MBS/ABS (RCFD1754+RCFD1773 - (RCFD8500 + RCFD8504 + RCFDC026 + RCFD8503 + RCFD8507 + RCFDC027)), divided by total assets. The Bank Capital Ratio variable is calculated as the book value of capital (RCFD3210) divided by total assets. The nonperforming loans ratio is defined as loans past due 90 days or more and nonaccruals (RCFD1407 + RCFD1403) divided by total loans (RCFD1400). Finally, lender size is calculated as total assets.

5.4 Credit Line Usage, Covenant Violations and Their Consequences

Table 1 provides univariate evidence on the differences in firm characteristics across the samples of firms with and without a line of credit. In column 1 we report mean and median values for the entire sample, while column 2 and 3 contain values for the sub-samples of firms with and without a line of credit, respectively. Table 1 allows for a broad comparison of firms with and without a line of credit. The main picture that emerges from the table is that the sample of firms with a line of credit is significantly different from the rest along all the dimensions reported in the table. Firms with a line of credit are more profitable, more leveraged, are more likely to pay dividends, have lower beta, and are more likely to be rated. These firms also invest more in working capital and capex, but have lower R&D expenses. Overall, these characteristics suggest that firms with a line of credit are more established, mature firms with fewer growth opportunities and more stable cash flows.

| TABLE 1 ABOUT HERE |

In our database we observe 2,288 instances of a covenant violation and in Table 3 we also display the frequency of each consequence following a covenant violation. Close to 17% of violations are fully waived by banks, but surprisingly waivers are much more frequent for small and unrated firms.19 Whereas firms larger than $250 m. enjoy full waiver rates of around 11%, firms below

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19Roberts and Sufi (2009) report a much higher frequency of waivers than us (63%). The large gap could be due to the following reasons. Our data includes the crisis (their sample is 1996-2005, ours 2002-2011), during which waivers fell substantially. In our data, the frequency was 21% in 2003-2007, 12% in 2008-2009, and 18% in 2010. They only look at three consequences (interest rate increase, partial and full revocation, and additional collateral), and they consider the residual as waivers, while we specifically look at waivers. We also record two other important consequences, covenant tightening (turns out to be the most frequent (34%) and the one that has most important consequences), and maturity shortenings, as well as the ‘others’ category. We have a residual category "others" in which we include cases in negotiation (this is somewhat frequent), and cases that could not clearly be classified
that size face waiver rates above 17%. Similarly, while rated firms enjoy a full waiver on only 8.62% of the cases on average, unrated firms do so on 17.92% of the cases. The most common consequences of a violation other than waivers are covenant adjustments (42.31% of the cases), interest rate increases (23.38%) and full or partial revocations (18.14%). It is important to stress that around 65% of covenant violations generate reactions from banks which are not full waivers or limit cuts. This point is important because many existing empirical papers measure the degree of commitment in lines of credit by evaluating the reductions in limits following covenant violations or a deterioration in a firm’s performance, but this evidence suggests that the bulk of the cases in which there is some reaction from a bank, such reaction is not a limit cut. We will next show that these non-revocation reactions are in fact associated with similar decreases in subsequent usage of lines of credit, suggesting that banks can effectively restrict access to line of credit indirectly, by means of alternative measures such as covenant tightenings or interest rate increases.

**Table 2 About Here**

In Figure 2 we present the evolution through time of covenant violations and their consequences. The frequency of covenant violations has been pretty stable during the 2002-2010 period, with a very small increase during 2008 and 2009. The frequency of waivers and revocations, however, displays a much more volatile pattern. Waivers were low in the initial periods (2002 and 2003), increases substantially during 2004-2005, and decreased substantially afterwards, particularly during 2008-2010 when they were about half as likely as in the 2004-2005 peak (22.37% in 2005 versus 10.97% and 10.90% in 2008 and 2009 respectively). A similar but inverted pattern is present for revocations. The revocation rate in 2009 was 21.47% while it was only 12.40% in 2006. Taken together, this evidence suggests that while violation frequency is pretty stable through time, banks’ reactions to these violations vary significantly with the business cycle and the state of financial markets.

**Figure 2 About Here**

into any of the buckets. The frequency of this event is high, 27%. Some of these may be waivers, expressed in a non-standard way. But we took the stand not to classify them as waivers. Waivers are relatively easy to pick up as they are typically expressed in a very clear and homogeneous way. Importantly, they look at covenants for all debt types (term loans, credit lines, and corporate bonds). Waiver frequency might be different for term loans and corporate bonds relative to LCs. Finally, the SEC introduced a new rule in 2003 specifying the reporting requirements concerning covenant violations and their consequences, which may bias their early data (they acknowledge this in the paper).

A plausible explanation for this evidence could be that firm-lender relationships, which enable firms to enjoy a higher rate of waivers following violations, are more relevant for smaller, unrated firms, although we do not pursue this question in this paper.

35
6 Ex-post effect of shocks to bank health on high quality firms

6.1 Bank Financial Health and Access to Credit Lines

In this section we explore whether the financial health of financial intermediaries affects their decision to restrict access to credit under available lines of credit following a covenant violation. This decision is captured by the variable \( \text{waiver} \), whose construction is explained in Section 5.4. We restrict ourselves to the sample of firms that have violated a covenant in period \( t \), and study how their lenders’ financial health, measured in \( t - 1 \), affects whether the covenants generate a restriction of access to undrawn credit or not. Our base specification for this analysis is as follows:

\[
\begin{align*}
\text{Waiver}_{i,t} &= \alpha_0 + \alpha_1 \text{BankHealth}_{i,t-1} + \alpha_2 \text{FirmControls}_{i,t-1} \\
&\quad + \alpha_3 \text{BankControls}_{i,t-1} + \varepsilon_{i,t}, \quad \text{if violation} = 1
\end{align*}
\]

where the subscript \( i \) refers to each firm, and \( \text{BankHealth}_{i,t} \) is constructed using two different measures, which are the changes in \( t - 1 \) in the liquidity ratios and the capital ratios of lenders. The set of firm level controls includes size, presence of a credit rating, profitability, the market-to-book ratio, and cash flow volatility. The set of bank level controls includes the capital ratio, size, the deposit ratio, the wholesale ratio, the liquidity ratio, and the nonperforming loans ratio.

The choice of bank health variables responds to existing evidence and theory from the literatures studying the bank lending channel of monetary policy. Kashyap and Stein (2000), Kishan and Opiela (2000) and Jimenez, Ongena, Peydró and Saurina (2012) find that liquid and well-capitalized banks display a lower sensitivity of their lending supply to monetary policy shocks. This suggests that these two measures might be relevant proxies for the degree of financing frictions facing banks, and thus of their ability and willingness to allow for drawdowns under loan commitments that can be legally withheld because there has been a covenant violation. We choose to measure bank financial health using changes rather than levels because the latter might expose us to two important sources of endogeneity biases due to selection and omitted variables bias. On the one hand, it is likely that there is some endogenous matching of banks to firms, possibly driven by bank health. On the other, contractual terms of the credit lines might also be endogenous and driven by bank health, even if matching to borrowers was exogenous. Using changes might expose us however to reverse causality because a worsening of borrowers’ risk causes a worsening of bank health, which would introduce a positive bias in the relationship between bank health and the waiver decision. To deal partially with this concern we use lagged values of our financial health measures.

Our prediction is that financially healthy banks are more likely than weak banks to waive
covenant violations ($\alpha_1 > 0$). We also conjecture that the strength of this effect is likely to be stronger during the recent financial crisis when compared to the pre-crisis period, and for this reason we run this regression separately on subsamples of crisis period and pre-crisis period observations. The crisis period is defined to include fiscal years 2007, 2008 and 2009, excluding firm-year observations of firms filing in June or July 2007. The pre-crisis period is defined to include fiscal years 2004, 2005 and 2006, and firm-year observations of firms filing in June or July 2007.

The results from running the Probit regression in 77 are displayed in Table 6, and are consistent with our prediction. Firms that have violated a covenant are more likely to get waived if their bank suffered an increase in its capital or liquidity ratio in the previous year, controlling for relevant firm and bank characteristics. This effect is only present during the crisis, and the difference between crisis and pre-crisis periods is statistically significant. The effects are economically stronger when we focus on firms that have access to substantial amounts of available lines of credit, suggesting that financially weak banks are even more reluctant to allow access to precommitted credit when firms have large credit lines. To get an idea of magnitudes, a two-standard deviation increase in the change in the capital ratio is associated at the mean with an increase of around 21% (=10.83*0.0192) in the likelihood of being waived. This effect increases to around 27% (=14.26*0.0192) for firms with available credit lines above 10% of total assets. Similar magnitudes (14% and 25%) are obtained when focusing on changes in bank liquidity ratios.

The information on which covenants are being violated is potentially very relevant for how a bank’s financial health affects its decision to waive or call a covenant violation. However, one aspect that is crucial for our story and is common to most (if not all) types of covenant violations is that they legally transfer the right to the lender to cancel the line of credit. A bank in financial distress which wishes to decrease its exposure to liquidity demands by its credit line customers needs the legal ability to do so, and the majority of covenant violations provide it. The type of covenant that is violated is of course still very relevant, although arguably more so for credit line cancellation decisions by financially healthy banks, which are based entirely on the firm’s financial condition.

A cause for concern in terms of possible biases in our estimation is that the types of covenants violated and bank financial health changes are related. This could be because banks’ preference for certain types of covenants is related to their financial health, or because a common factor drives bank health and the violation of certain types of covenants. We partly address these concerns by measuring bank health as lagged changes, and by controlling for a large set of bank characteristics.
A key area for future research is to expand the analysis to include as much information as possible on the types of covenants being violated.

### 6.2 Capital Structure Implications of Covenant Violations

Having shown that bank financial health has an impact on whether a firm retains access to precommitted credit following a covenant violation, we next explore the capital structure implications of the waiver decision. Our prediction is that firms that have violated a covenant cannot raise much financing, except if covenants are waived and they retained some access to their credit lines. If this is proven to be so, it carries the implication that firms become effectively bank-dependent following a covenant violation.

We explore this prediction using two tests. First, we test whether firms that violate a covenant during the crisis and are waived see drawn credit lines increase in importance as a source of external finance. We do so by testing whether drawn credit lines as a share of total bank debt, total debt, or total assets, increases in the year after a covenant violation if the covenants are waived by the lenders, and also by testing if the difference between the change in the importance of drawn credit lines between waived and non-waived firms is positive and significant. We do so by running the following regression:

\[
\Delta \text{DrawnCreditLines}_t / X_{t-1} = \alpha_0 + \alpha_1 \text{DummyViolation}_{t-1} + \alpha_2 \text{DummyViolation}_{t-1} \ast \text{Waiver}_{t-1} + \alpha_3 \text{FirmControls}_{i;t} + \varepsilon_{i;t},
\]  

where \(X_{t-1}\) is either total bank debt, total debt, or total assets. We predict \(\alpha_1\) to be negative, \(\alpha_2\) to be positive, and \(\alpha_1 < \alpha_2\), such that the net effect of a waived covenant violation for a firm is to experience an increase in the dependence on credit lines as a source of finance.

The results of running regression (78) on the sample of all firms during the crisis period is displayed in Table 7. We find that while firms that violated a covenant and were not waived suffered a large decrease in drawn credit lines as a share of total bank debt, total debt, or total assets, for those that were waived drawn credit lines increased as a share of bank debt, total debt, or total assets, in the year after the violation. In terms of economic significance, while a covenant violation that is not waived is associated with a fall in the drawn credit line to total bank debt ratio of around 10 percentage points, a waived violation is associated with an increase of around 4 percentage points. As a share of total assets, a non-waived firm loses drawn credit equivalent to
3% of assets, while a waived one sees an increase equivalent to around 0.5 to 1% of assets.

The waiver decision is clearly endogenous, which gives rise to concerns about estimation biases due to omitted variables, despite the fact that our results are robust to including a rich set of firm level controls. The concerns are attenuated due to the fact that there is no clear unobserved firm characteristic that might be driving both the waiver decision and the dependence on credit lines as a source of external finance in the same direction. Nonetheless, to deal with these concerns we introduce an instrumental variables regression analysis in which we deal with the possible endogeneity of DummyViolation*Waiver. As instruments, we use the change in lender liquidity ratio and the change in lender capital ratio. The rationale for these instruments is based on the observed positive relation between them and the waiver decision following a covenant violation, as shown in the results of Table 6 discussed in Section 6.1 (relevance condition), but that the health of a bank in period \( t - 2 \) is unlikely to directly affect the change in the relative importance of credit lines in the capital structure of a firm in period \( t \) (exclusion restriction). The results of our instrumental variables regressions are in Table 8 and confirm our results obtained in the regressions of Table 7.

Second, we dig deeper into which financing flows are responsible for the observed changes in capital structure, and test whether firms that violate a covenant during the crisis and are waived see net drawdowns of credit lines increase and net variations in bonds, equity, and loan financing decrease, while those covenant violators which are not waived see a decrease in the net variation of all forms of external finance. We measure net drawdowns of credit lines during period \( t \) as drawdowns net of repayment of outstanding drawn credit lines during period \( t \), over total assets at the end of period \( t - 1 \), and net variations in loans and bonds similarly. Net equity issues are defined as the sale of common and preferred stock during period \( t \) net of the purchase of common and preferred stock, relative to total assets at the end of period \( t - 1 \). We run a similar regression to (78), in which the dependent variables are the net variations in each of the four financing instruments.

The results for this analysis are displayed in Table 9. Net loan originations and equity issues are relatively unresponsive both to waived and non-waived covenant violations, while credit line drawdowns and bond issues react strongly. Firms that violate a covenant and are not waived by their lenders suffer a decrease in net credit line drawdowns equivalent to around 2.5% of total assets.
Firms that violate a covenant and are waived experience an increase of roughly the same size. These patterns seem to be compensated by the behavior of net bond issues. Firms that violate a covenant and are not waived by their lenders experience an increase of around 1.8% of total assets in net bond issuance, in contrast with firms that violate a covenant and are waived, which experience a decrease of around 2.1%. In short, covenant violations apparently induce an important change in the composition of external finance. Firms that violate covenants and lose access to lines of credit switch to bond issuance but do not fully compensate for the lost bank finance. On the other hand, firms that violate covenants but retain access to credit lines decrease their usage of bond financing and compensate the loss by drawing down on their lines of credit. The precise type of covenant being violated can affect the capital structure implications of violations in an important way, and the lack of information about this aspect limits our analysis of this point.

Taken together, this evidence suggests that firms that violate a covenant see the relative cost of non-credit line finance increase. So even if firms that were revoked during the crisis retained access to bond financing, the preference of the waived ones for credit line financing must mean that the waiver outcome ultimately has a potentially large impact on the cost of capital, and hence potentially also on investment and hiring. We explore the real implications of covenant violations and their consequences for access to precommitted credit in the next section.

6.3 Real Implications of Covenant Violations and Banks’ Waiver Decisions

So far the evidence has shown that the degree of restriction of access to bank lines of credit imposed following a covenant violation has important implications for firms’ external finance composition, and that the waiver decision is influenced by lenders’ financial health. This opens the possibility of a novel mechanism through which the health of the financial sector gets transmitted to the real economy, by affecting the access to precommitted credit that firms that have violated a covenant on a debt product have. The prediction of this novel mechanism is that firms that have violated a covenant and had access to their credit lines revoked because they were insured by weak banks invested less, hired less and performed worse than similar firms that had covenants waived because they were borrowing from relatively stronger banks. To test this prediction, we restrict ourselves to the sample of firms that have violated a covenant in period t, and study how their lenders’ financial health, measured in $t – 1$, affects whether the performance of the firm in period
$t + 1$. Our base specification for this analysis is as follows:

$$Performance_{i,t} = \alpha_0 + \alpha_1 Waiver_{i,t-1} + \alpha_2 FirmControls_{i,t-1} + \alpha_3 BankControls_{i,t-2} + \varepsilon_{i,t}, \quad \text{if violation}=1$$

(79)

where $Waiver_{i,t-1}$ is instrumented using our main measures of bank health, which are the changes in $t-2$ in the liquidity ratios and the capital ratios of lenders. The timing of the variables in this regression reflects the characteristics of the effects we are trying to test. We are interested in the real implications in period $t$ of a covenant violation in period $t-1$, whose outcome in terms of a waiver or a revocation is driven by changes in lender health during period $t-2$. The set of firm level controls includes size, presence of a credit rating, profitability, the market-to-book ratio, and cash flow volatility. The set of bank level controls includes the capital ratio, size, the deposit ratio, the wholesale ratio, the liquidity ratio, and the nonperforming loans ratio. As performance measures we focus on changes in capital expenditures, scaled by previous year assets, changes in employment relative to the previous year’s total workforce, changes in sales over total assets in the previous period, and the variation in profitability.

The rationale for our choice of the liquidity ratios and the capital ratios of lenders as instruments for the waiver variable is based on the evidence that the waiver decision is strongly associated to these bank health measures (relevance condition), as shown in the results of regression (77) in Section 6.1, but that these bank health measures do not directly impact firm performance (exclusion restriction). The reasoning for the exclusion condition is that changes in period $t-2$ in bank health are unlikely to have an impact on investment, hiring, or sales of firms in period $t$, other than through the waiver-revocation decision, for the sample of firms that have violated a covenant.

The result of running the instrumental variables regression (79) is in Table 10. We find significant evidence consistent with the prediction that firms that have violated a covenant and had access to their credit lines revoked because their banks were in poor financial health invested and hired less and performed relatively worse than those firms that had their covenants waived because they were borrowing from relatively stronger banks. Results are sometimes larger in economic magnitude for firms with substantial access to lines of credit, relative to those that have access to smaller amounts of precommitted credit, as would be expected, but their statistical significance is typically lower due to the loss in the number of observations. The economic magnitudes are significant. Revocations of credit lines induced by poor bank health are associated on average with
drops in profitability about 10% larger and drops in hiring about 20% larger, relative to those firms that were waived.

7 Ex-ante effect of shocks to bank health on high quality firms

In this section we test the ex-ante effect of shocks to bank health on firms that rely on credit lines for liquidity management. Our theory predicts that a negative shock to bank capital or bank liquidity causes high credit quality firms to substitute credit lines for cash in their liquidity management, and particularly so during the crisis. To test this prediction, we restrict our sample to firms that have access to a credit line but that are not in violation of a covent.

Our empirical specification explores whether \( BankHealth_{i,t} \), our measure of bank financial condition, constructed as before using the changes in \( t-1 \) in the liquidity ratios and the capital ratios of a firm’s lenders, is associated with a firm’s liquidity management policy. We measure changes in liquidity management as the change in the cash to total liquidity ratio between \( t-1 \) and \( t \). Total liquidity is equal to cash holdings plus available undrawn credit lines.

The results are in Table 11. Firms increase their cash to total liquidity ratio when their lenders suffered a decrease in their capital or liquidity ratio in the previous year. This effect is present during the crisis and also before, with no significant difference in the strength across the two periods. The reason for the lack of difference between the crisis and non-crisis periods could be due the mixing of ex-ante and ex-post effects during the crisis. Ex-post firms may have to reduce cash to meet current obligations if their lenders cut funding. To deal with this concern, we sort firms according to proxies for financial health, under the assumption that the ex-post effect is present only for those in poor health so the effect may be driven by those in better health. We further restrict our sample to firms that are in the top quartile of size, rated, and dividend payers. The results are in Table 12, where we find that for the subset of financially unconstrained firms the cash ratio is only significantly related to lender health during the crisis. In terms of economic magnitudes: for the full sample, a one standard deviation decrease in a firm’s lenders' capital ratio or liquidity ratio is associated on average with an increase in cash holdings as a share of total liquidity of around 1.5 percentage points on average, inside or outside of the crisis. For the subsample of financially unconstrained, the same deterioration in bank health is associated with an increase of around 4 percentage points inside the crisis, and is insignificant outside of the crisis.
8 References


Figure 1: Equilibrium in State $\theta$ as a Function of Bank Capital $K_1$. 

- Saving (borrowing) by banks
- Lending to low credit quality firms
- Investment by low credit quality firms
- Probability of date-2 revocation
- High Credit Quality Firm Early Drawdowns
- Date-2 Bank liquidity
Figure 2. Time Trends in Covenant Violations and Their Consequences

These graphs provide times series evidence of the evolution of covenant violations and their consequences between 2002 and 2010. In the bottom figures, Small Firms are those in the bottom tercile of size measured by assets, while Large Firms are those in the top tercile.
Table 1
Comparison of Firms with and without Credit Lines

This table provides summary statistics for the entire sample and for the restricted samples of firms with and without a credit line. The entire sample consists of non-utilities (excluding SIC codes 4900-4949) and non-financials (excluding SIC codes 6000-6999) U.S. firms covered by both Capital IQ and Compustat from 2002 to 2011. We have removed firm-years with 1) negative revenues, and 2) negative or missing assets. After the above filters, the sample consists of 32,671 firm-year observations involving 4,741 unique firms. In this table, “size” is measured as the book value of assets. All variables are winsorized at the 0.5% in both tails of the distribution. The last two columns test for differences between samples with and without undrawn credit using the unequal variances t-test and the two-sample Wilcoxon rank-sum (Mann-Whitney) test.

<table>
<thead>
<tr>
<th></th>
<th>Entire Sample</th>
<th>Sample of Firms with a Credit Line</th>
<th>Sample of Firms without a Credit Line</th>
<th>Test of Difference with vs. without a Credit Line</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean</td>
<td>Median [Median]</td>
<td>Mean [Median]</td>
<td>t-test [Median] [Median]</td>
</tr>
<tr>
<td>Cash/ Net At</td>
<td>0.657</td>
<td>0.350 [0.147]</td>
<td>1.517 [0.576]</td>
<td>45.658 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>80.044 [0.000]</td>
</tr>
<tr>
<td>Credit Lines/Net At</td>
<td>0.106</td>
<td>0.156 [0.071]</td>
<td>0.156 [0.124]</td>
<td></td>
</tr>
<tr>
<td>Cash/ Net At (market value)</td>
<td>0.115</td>
<td>0.093 [0.054]</td>
<td>0.185 [0.100]</td>
<td>33.527 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>50.649 [0.000]</td>
</tr>
<tr>
<td>Credit Lines/Net At (market value)</td>
<td>0.067</td>
<td>0.096 [0.041]</td>
<td>0.096 [0.071]</td>
<td></td>
</tr>
<tr>
<td>Profitability</td>
<td>0.059</td>
<td>0.097 [0.107]</td>
<td>-0.048 [0.119]</td>
<td>-46.411 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-52.245 [0.000]</td>
</tr>
<tr>
<td>Size</td>
<td>2181.0</td>
<td>2618.9 [317.2]</td>
<td>952.8 [453.8]</td>
<td>-30.560 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-55.191 [0.000]</td>
</tr>
<tr>
<td>Book Leverage</td>
<td>0.211</td>
<td>0.232 [0.152]</td>
<td>0.151 [0.192]</td>
<td>-30.678 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-49.071 [0.000]</td>
</tr>
<tr>
<td>M/B</td>
<td>1.728</td>
<td>1.576 [1.232]</td>
<td>2.195 [1.152]</td>
<td>28.841 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>32.753 [0.000]</td>
</tr>
<tr>
<td>Tangibility</td>
<td>0.248</td>
<td>0.273 [0.167]</td>
<td>0.177 [0.197]</td>
<td>-39.567 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-47.168 [0.000]</td>
</tr>
<tr>
<td>NWC/At</td>
<td>0.050</td>
<td>0.076 [0.042]</td>
<td>-0.019 [0.064]</td>
<td>-43.110 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-44.129 [0.000]</td>
</tr>
<tr>
<td>Capex/At</td>
<td>0.054</td>
<td>0.057 [0.033]</td>
<td>0.045 [0.036]</td>
<td>-16.503 [0.000]</td>
</tr>
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<td></td>
<td></td>
<td></td>
<td></td>
<td>-56.371 [0.000]</td>
</tr>
<tr>
<td>R&amp;D/Sales</td>
<td>0.370</td>
<td>0.136 [0.005]</td>
<td>1.034 [0.000]</td>
<td>29.731 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>63.398 [0.000]</td>
</tr>
<tr>
<td>Dividend Payer</td>
<td>0.275</td>
<td>0.330 [0.000]</td>
<td>0.117 [0.000]</td>
<td>-49.989 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-80.888 [0.000]</td>
</tr>
<tr>
<td>Beta KMV</td>
<td>1.245</td>
<td>1.176 [1.099]</td>
<td>1.419 [1.054]</td>
<td>13.428 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>12.227 [0.000]</td>
</tr>
<tr>
<td>Rating Dummy</td>
<td>0.265</td>
<td>0.327 [0.265]</td>
<td>0.092 [0.000]</td>
<td>-59.701 [0.000]</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td>-46.715 [0.000]</td>
</tr>
<tr>
<td>Observations</td>
<td>32671</td>
<td>22186 [32671]</td>
<td>10485 [0.000]</td>
<td></td>
</tr>
</tbody>
</table>
Table 2
How covenant violations and their consequences vary across the sample

This table provides summary statistics related to credit line covenant violations and their consequences for the sample of firms with a credit line at the beginning of the period (26,578 firm-years), and summary statistics of the consequences of these violations for the subset of firms that have violated a covenant in a given year. It combines data from a text search of all 10-K filings for the Compustat universe of U.S. firms for 2002 to 2011 with data from Capital IQ. There is a residual violation consequence which is not reported, which includes cases in negotiation and consequences which are different from any of the above. Note that covenant violations often generate more than one consequence.

<table>
<thead>
<tr>
<th>Consequences (conditional on a violation)</th>
<th>Percentage of firms reporting a violation</th>
<th>Waiver</th>
<th>Full or Partial Revocation</th>
<th>Interest rate increase</th>
<th>Maturity Shortening</th>
<th>Covenant Adjustment</th>
<th>Asset Pledge</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Totals</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Total sample</td>
<td>6.18%</td>
<td>16.96%</td>
<td>18.14%</td>
<td>23.38%</td>
<td>9.75%</td>
<td>42.31%</td>
<td>9.04%</td>
</tr>
<tr>
<td>Firms with book leverage &gt; 0.05</td>
<td>6.34%</td>
<td>16.33%</td>
<td>16.88%</td>
<td>22.51%</td>
<td>9.13%</td>
<td>44.74%</td>
<td>8.49%</td>
</tr>
<tr>
<td><strong>By Industry</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Agric., minerals, construction</td>
<td>5.13%</td>
<td>3.16%</td>
<td>11.58%</td>
<td>27.37%</td>
<td>16.84%</td>
<td>55.79%</td>
<td>8.42%</td>
</tr>
<tr>
<td>Manufacturing</td>
<td>4.73%</td>
<td>19.11%</td>
<td>17.41%</td>
<td>18.18%</td>
<td>8.47%</td>
<td>41.76%</td>
<td>7.70%</td>
</tr>
<tr>
<td>Transp., comm., and utilities</td>
<td>5.96%</td>
<td>14.02%</td>
<td>25.23%</td>
<td>22.43%</td>
<td>10.28%</td>
<td>42.99%</td>
<td>6.54%</td>
</tr>
<tr>
<td>Trade—wholesale</td>
<td>5.82%</td>
<td>16.39%</td>
<td>18.03%</td>
<td>24.59%</td>
<td>1.64%</td>
<td>42.62%</td>
<td>16.39%</td>
</tr>
<tr>
<td>Trade—retail</td>
<td>4.75%</td>
<td>19.42%</td>
<td>8.74%</td>
<td>21.36%</td>
<td>3.88%</td>
<td>30.10%</td>
<td>1.94%</td>
</tr>
<tr>
<td>Services</td>
<td>5.26%</td>
<td>21.97%</td>
<td>15.92%</td>
<td>20.70%</td>
<td>6.69%</td>
<td>42.68%</td>
<td>7.96%</td>
</tr>
<tr>
<td><strong>By Size (Book Assets)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Less than $100M</td>
<td>8.53%</td>
<td>20.52%</td>
<td>16.64%</td>
<td>19.87%</td>
<td>10.07%</td>
<td>39.83%</td>
<td>8.50%</td>
</tr>
<tr>
<td>$100M to $250M</td>
<td>7.30%</td>
<td>17.49%</td>
<td>19.62%</td>
<td>25.77%</td>
<td>7.33%</td>
<td>45.63%</td>
<td>10.87%</td>
</tr>
<tr>
<td>$250M to $500M</td>
<td>6.05%</td>
<td>11.81%</td>
<td>19.19%</td>
<td>27.68%</td>
<td>14.76%</td>
<td>45.76%</td>
<td>8.86%</td>
</tr>
<tr>
<td>$500M to $1,000M</td>
<td>5.60%</td>
<td>11.20%</td>
<td>18.67%</td>
<td>29.05%</td>
<td>9.13%</td>
<td>45.23%</td>
<td>11.62%</td>
</tr>
<tr>
<td>$1,000M to $2,500M</td>
<td>3.66%</td>
<td>10.00%</td>
<td>23.75%</td>
<td>26.25%</td>
<td>7.50%</td>
<td>44.38%</td>
<td>6.25%</td>
</tr>
<tr>
<td>$2,500M to $5,000M</td>
<td>2.74%</td>
<td>11.48%</td>
<td>14.75%</td>
<td>22.95%</td>
<td>8.20%</td>
<td>40.98%</td>
<td>1.64%</td>
</tr>
<tr>
<td>Borrower has no credit rating</td>
<td>6.93%</td>
<td>17.92%</td>
<td>17.97%</td>
<td>23.27%</td>
<td>9.77%</td>
<td>41.97%</td>
<td>9.18%</td>
</tr>
<tr>
<td>Borrower has credit rating</td>
<td>3.11%</td>
<td>8.62%</td>
<td>20.26%</td>
<td>25.43%</td>
<td>9.05%</td>
<td>44.40%</td>
<td>8.62%</td>
</tr>
</tbody>
</table>
Table 3
Are healthy lenders more likely to waive covenant violations, particularly so during the crisis?
This table presents Probit regression results to study the relation between the financial health of a firm’s lenders and the occurrence of a waiver on a debt covenant violation. The sample consists of firm-years in which a firm suffered a covenant violation on any debt product, between 2004 and 2009. Columns 1 and 2 contain regressions for the crisis period, which starts in August 2007 and ends in May 2010. Columns 3 and 4 contain regressions for the pre-crisis period, which starts in June 2004 and ends in July 2007. The regression reports marginal effects. All control variables are lagged. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

<table>
<thead>
<tr>
<th></th>
<th>Crisis Period</th>
<th></th>
<th>Pre-Crisis Period</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Dep Var: Waiver (dummy)</td>
<td>Firms with LC</td>
<td>LC&gt;10% Assets</td>
<td>Firms with LC</td>
<td>LC&gt;10% Assets</td>
</tr>
<tr>
<td>Change in Lender Capital Ratio$\Delta t$</td>
<td>10.83***</td>
<td>14.26***</td>
<td>3.659</td>
<td>5.298</td>
</tr>
<tr>
<td></td>
<td>(2.669)</td>
<td>(2.624)</td>
<td>(1.346)</td>
<td>(1.360)</td>
</tr>
<tr>
<td>Change in Lender Liquidity Ratio$\Delta t$</td>
<td>2.005*</td>
<td>3.537**</td>
<td>0.307</td>
<td>1.232</td>
</tr>
<tr>
<td></td>
<td>(1.818)</td>
<td>(2.302)</td>
<td>(0.290)</td>
<td>(0.834)</td>
</tr>
<tr>
<td>Size$\Delta t$</td>
<td>-0.065***</td>
<td>-0.096***</td>
<td>-0.0820***</td>
<td>-0.097***</td>
</tr>
<tr>
<td></td>
<td>(-3.090)</td>
<td>(-2.949)</td>
<td>(-3.614)</td>
<td>(-2.800)</td>
</tr>
<tr>
<td>Rated$\Delta t$</td>
<td>-0.0138</td>
<td>-0.0871</td>
<td>-0.0556</td>
<td>-0.001</td>
</tr>
<tr>
<td></td>
<td>(-0.203)</td>
<td>(-0.918)</td>
<td>(-0.758)</td>
<td>(-0.008)</td>
</tr>
<tr>
<td>Profitability$\Delta t$</td>
<td>-0.320</td>
<td>-0.185</td>
<td>-0.191</td>
<td>-0.181</td>
</tr>
<tr>
<td></td>
<td>(-1.223)</td>
<td>(-0.692)</td>
<td>(-0.920)</td>
<td>(-0.638)</td>
</tr>
<tr>
<td>Lender Capital Ratio$\Delta t$</td>
<td>-6.775***</td>
<td>-7.477</td>
<td>-1.276</td>
<td>1.117</td>
</tr>
<tr>
<td></td>
<td>(-1.999)</td>
<td>(-1.630)</td>
<td>(-0.438)</td>
<td>(0.253)</td>
</tr>
<tr>
<td>Lender Size$\Delta t$</td>
<td>-0.00162</td>
<td>-0.0164</td>
<td>-0.0231</td>
<td>-0.0147</td>
</tr>
<tr>
<td></td>
<td>(-0.0646)</td>
<td>(-0.549)</td>
<td>(-1.134)</td>
<td>(-0.520)</td>
</tr>
<tr>
<td>Lender Deposit Ratio$\Delta t$</td>
<td>-2.360*</td>
<td>-2.796*</td>
<td>-1.111</td>
<td>-0.152</td>
</tr>
<tr>
<td></td>
<td>(-1.872)</td>
<td>(-1.915)</td>
<td>(-1.431)</td>
<td>(-0.127)</td>
</tr>
<tr>
<td>Lender Liquidity Ratio$\Delta t$</td>
<td>-1.040**</td>
<td>-0.800</td>
<td>0.287</td>
<td>1.136**</td>
</tr>
<tr>
<td></td>
<td>(-2.494)</td>
<td>(-1.621)</td>
<td>(0.761)</td>
<td>(2.135)</td>
</tr>
<tr>
<td>Lender Non-Perform Ratio$\Delta t$</td>
<td>-10.85***</td>
<td>-13.23***</td>
<td>-5.896</td>
<td>11.28</td>
</tr>
<tr>
<td></td>
<td>(-3.524)</td>
<td>(-3.274)</td>
<td>(-0.628)</td>
<td>(0.803)</td>
</tr>
</tbody>
</table>

Observations 397 209 458 236
R-squared 0.101 0.152 0.0704 0.100
This table presents regression results to study the relation between the covenant violations, the waiver decision of the lender, and bank dependence. Columns (1) and (2) study how drawn credit lines as a share of total bank debt (drawn credit lines plus term loans outstanding) is affected by covenant violations that occurred in the previous year and by the lender’s waiver decision. Columns (3) and (4) focus on the response of drawn credit lines as a share of total debt (bank debt plus bonds outstanding), and columns (5) and (6) on the response of drawn credit lines over total assets. The sample consists of firms in the top quartile of undrawn credit line availability (firms with credit lines at the end of the previous year in excess of 15% of total assets) during the crisis years of 2008 and 2009. All control variables are lagged. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

<table>
<thead>
<tr>
<th></th>
<th>Δ(Drawn Credit Lines / Bank Debt)</th>
<th>Δ(Drawn Credit Lines / Total Debt)</th>
<th>Δ(Drawn Credit Lines / Total Assets)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td></td>
<td>No Controls</td>
<td>Controls</td>
<td>No Controls</td>
</tr>
<tr>
<td>Covenant Violationt-1 (dummy)</td>
<td>-0.110**</td>
<td>-0.106**</td>
<td>-0.0988**</td>
</tr>
<tr>
<td></td>
<td>(-2.416)</td>
<td>(-2.355)</td>
<td>(-2.406)</td>
</tr>
<tr>
<td>Covenant Violationt-1*Waiver t-1</td>
<td>0.161**</td>
<td>0.142**</td>
<td>0.116**</td>
</tr>
<tr>
<td></td>
<td>(2.526)</td>
<td>(2.270)</td>
<td>(2.079)</td>
</tr>
<tr>
<td>Size t-1</td>
<td></td>
<td>-0.0145**</td>
<td>-0.0179***</td>
</tr>
<tr>
<td></td>
<td>(-2.501)</td>
<td>(-2.772)</td>
<td>(-0.741)</td>
</tr>
<tr>
<td>Rated t-1 (dummy)</td>
<td>0.0333</td>
<td>0.0255</td>
<td>0.00376</td>
</tr>
<tr>
<td></td>
<td>(1.443)</td>
<td>(1.208)</td>
<td>(0.533)</td>
</tr>
<tr>
<td>Market-to-Book t-1</td>
<td>-0.0181</td>
<td>0.0129</td>
<td>0.00412</td>
</tr>
<tr>
<td></td>
<td>(-1.427)</td>
<td>(1.035)</td>
<td>(1.156)</td>
</tr>
<tr>
<td>Profitability t-1</td>
<td>0.0541</td>
<td>-0.0548</td>
<td>-0.00113</td>
</tr>
<tr>
<td></td>
<td>(1.113)</td>
<td>(-0.937)</td>
<td>(-0.0904)</td>
</tr>
<tr>
<td>Observations</td>
<td>1,400</td>
<td>1,337</td>
<td>1,123</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.005</td>
<td>0.011</td>
<td>0.005</td>
</tr>
</tbody>
</table>
**Table 5**

**Covenant Violations and Dependence on Bank Lines of Credit: Instrumental Variables Estimation**

This table presents instrumental variables regression results to study the relation between the covenant violations, the waiver decision of the lender, and bank dependence. The endogenous variable being instrumented is the interaction term \( \text{Covenant Violation} \times \text{Waiver} \) and the instruments are \( \text{Change in Lender Liquidity Ratio} \) and \( \text{Change in Lender Capital Ratio} \). Columns (1) and (2) study how drawn credit lines as a share of total bank debt (drawn credit lines plus term loans outstanding) is affected by covenant violations that occurred in the previous year and by the lender’s waiver decision. Columns (3) and (4) focus on the response of drawn credit lines as a share of total debt (bank debt plus bonds outstanding), and columns (5) and (6) on the response of drawn credit lines over total assets. The sample consists of firms in the top quartile of undrawn credit line availability (firms with credit lines at the end of the previous year in excess of 15% of total assets) during the crisis years of 2008 and 2009. All control variables are lagged. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

<table>
<thead>
<tr>
<th></th>
<th>Δ(Drawn Credit Lines / Bank Debt)</th>
<th>Δ(Drawn Credit Lines / Total Debt)</th>
<th>Δ(Drawn Credit Lines / Total Assets)</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
</tr>
<tr>
<td>Covenant Violation(_{t-1}) (dummy)</td>
<td>-1.029 (-1.127)</td>
<td>-0.884 (-1.120)</td>
<td>-1.447* (-1.778)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-1.440** (-2.499)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-1.369* (-1.651)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>-0.931** (-1.990)</td>
</tr>
<tr>
<td>Covenant Violation(<em>{t-1}) × Waiver(</em>{t-1})</td>
<td>2.730 (1.120)</td>
<td>2.451 (1.099)</td>
<td>3.397* (1.786)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.842** (2.474)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>3.350 (1.624)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>2.333* (1.943)</td>
</tr>
<tr>
<td>Size(_{t-1})</td>
<td>0.0253 (0.674)</td>
<td>0.0474 (1.589)</td>
<td>0.0122 (1.012)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.0170 (1.012)</td>
</tr>
<tr>
<td>Rated(_{t-1}) (dummy)</td>
<td>-0.0477 (-0.615)</td>
<td>-0.103 (-1.481)</td>
<td>-0.0295 (-0.864)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market-to-Book(_{t-1})</td>
<td>-0.00145 (-0.0846)</td>
<td>0.0170 (0.716)</td>
<td>0.0197* (1.809)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.0926 (0.933)</td>
</tr>
<tr>
<td>Profitability(_{t-1})</td>
<td>0.134 (0.750)</td>
<td>0.571* (1.942)</td>
<td>0.002 (0.933)</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Observations</td>
<td>1,148</td>
<td>1,114</td>
<td>1,250</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1,245</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1,735</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>1,682</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.001</td>
<td>0.017</td>
<td>0.002</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td>0.002</td>
</tr>
</tbody>
</table>
Table 6
Covenant Violations and Issuance of Bonds and Equity, Origination of Bank Loans, and Drawdowns of Credit Lines

This table presents regression results to study the relation between the covenant violations, the waiver decision of the lender, and net variations in different financing instruments. Columns (1) and (2) study credit line drawdowns, net of repayments of outstanding drawn amounts and as a share of total assets, on the year after a covenant violation. Columns (3) and (4) focus on the response of net spot loan originations, and columns (5) and (6) on net bond issues. Columns (7) and (8) study net equity issues. The sample consists of firms in the top quartile of undrawn credit line availability (firms with credit lines at the end of the previous year in excess of 15% of total assets) during the crisis years of 2008 and 2009. All control variables are lagged. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

<table>
<thead>
<tr>
<th></th>
<th>Net Credit Line Drawdowns</th>
<th>Net Loan Originations</th>
<th>Net Bond Issues</th>
<th>Net Equity Issues</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>(1)</td>
<td>(2)</td>
<td>(3)</td>
<td>(4)</td>
</tr>
<tr>
<td>Covenant Violation_{t-1} (dummy)</td>
<td>-0.025**</td>
<td>-0.025**</td>
<td>-0.009</td>
<td>-0.008</td>
</tr>
<tr>
<td></td>
<td>(-2.508)</td>
<td>(-2.551)</td>
<td>(-1.020)</td>
<td>(-1.017)</td>
</tr>
<tr>
<td>Covenant Violation_{t-1}*Waiver_{t-1}</td>
<td>0.021</td>
<td>0.023*</td>
<td>-0.006</td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td>(1.572)</td>
<td>(1.663)</td>
<td>(-0.493)</td>
<td>(-0.420)</td>
</tr>
<tr>
<td>Size_{t-1}</td>
<td></td>
<td>0.001</td>
<td>0.002***</td>
<td>0.005***</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.229)</td>
<td>(2.821)</td>
<td>(4.749)</td>
</tr>
<tr>
<td>Rated_{t-1} (dummy)</td>
<td></td>
<td>-0.002</td>
<td>-0.012**</td>
<td>-0.004</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(-0.556)</td>
<td>(-2.510)</td>
<td>(-0.795)</td>
</tr>
<tr>
<td>Market-to-Book_{t-1}</td>
<td></td>
<td>0.001</td>
<td>0.001**</td>
<td>0.001*</td>
</tr>
<tr>
<td></td>
<td></td>
<td>(1.198)</td>
<td>(2.075)</td>
<td>(1.719)</td>
</tr>
</tbody>
</table>

| Observations | 2,238 | 2,148 | 2,231 | 2,144 | 2,209 | 2,127 | 1,989 | 1,908 |
| R-squared     | 0.050 | 0.051 | 0.010 | 0.018 | 0.002 | 0.016 | 0.001 | 0.177 |
Table 7

Do firms that borrow from healthy lenders perform better following a covenant violation?

This table presents instrumental variables regression results to study the relation between the financial health of a firm’s lenders and the performance of the firm following a debt covenant violation. The waiver decision is instrumented using Change in Lender Capital Ratio and Change in Lender Liquidity Ratio in the year before the covenant violation. The sample consists of firm-years in which a firm suffered a covenant violation on any debt product during the crisis period between August 2007 and May 2010. All control variables are lagged. Robust standard errors are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

<table>
<thead>
<tr>
<th>Dep Var: Performance Measure</th>
<th>Sales Growth$_{t+1}$</th>
<th>Change in Profitability$_{t+1}$</th>
<th>Workforce Growth$_{t+1}$</th>
<th>Investment$_{t+1}$</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Firms with LC</td>
<td>LC&gt;15% Assets</td>
<td>Firms with LC</td>
<td>LC&gt;15% Assets</td>
</tr>
<tr>
<td>Waiver$_{t-1}$</td>
<td>1.072**</td>
<td>0.786*</td>
<td>0.0837*</td>
<td>0.109</td>
</tr>
<tr>
<td></td>
<td>(2.403)</td>
<td>(1.882)</td>
<td>(1.741)</td>
<td>(1.606)</td>
</tr>
<tr>
<td>Size$_{t-1}$</td>
<td>0.104*</td>
<td>0.163*</td>
<td>0.00379</td>
<td>0.0102</td>
</tr>
<tr>
<td></td>
<td>(1.845)</td>
<td>(1.942)</td>
<td>(0.525)</td>
<td>(1.026)</td>
</tr>
<tr>
<td>Rated$_{t-1}$ (dummy)</td>
<td>0.0195</td>
<td>-0.277</td>
<td>0.0141</td>
<td>0.00798</td>
</tr>
<tr>
<td></td>
<td>(0.183)</td>
<td>(-1.153)</td>
<td>(0.978)</td>
<td>(0.443)</td>
</tr>
<tr>
<td>Market to Book Ratio$_{t-1}$</td>
<td>0.170***</td>
<td>0.132**</td>
<td>0.00915</td>
<td>0.0105</td>
</tr>
<tr>
<td></td>
<td>(3.144)</td>
<td>(2.202)</td>
<td>(1.292)</td>
<td>(1.229)</td>
</tr>
<tr>
<td>Observations</td>
<td>221</td>
<td>62</td>
<td>221</td>
<td>193</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.110</td>
<td>0.091</td>
<td>0.015</td>
<td>0.013</td>
</tr>
</tbody>
</table>
Table 8
Ex-ante effect of shocks to bank health on high quality firms

<table>
<thead>
<tr>
<th>Dependent Variable:</th>
<th>LC &gt; 0 (1)</th>
<th>LC &gt; 0.05 (2)</th>
<th>LC &gt; 0.1 (3)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in Firm Cash Ratio(t_{-1})</td>
<td>Crisis</td>
<td>Pre-Crisis</td>
<td>Crisis</td>
</tr>
<tr>
<td>Change in Lender Capital Ratio(t_{-1})</td>
<td>(-1.913^*)</td>
<td>(-1.331^{***})</td>
<td>(-2.226^{**})</td>
</tr>
<tr>
<td>Lender Capital Ratio(t_{-1})</td>
<td>(-0.268)</td>
<td>(-0.225)</td>
<td>(0.0136)</td>
</tr>
<tr>
<td>Lender Liquidity Ratio(t_{-1})</td>
<td>(-0.339^*)</td>
<td>(-0.492^{***})</td>
<td>(-0.327)</td>
</tr>
<tr>
<td>Lender Wholesale Ratio(t_{-1})</td>
<td>(-1.213)</td>
<td>(-1.211)</td>
<td>(-0.952)</td>
</tr>
<tr>
<td>Lender Deposit Ratio(t_{-1})</td>
<td>(-0.081)</td>
<td>(-0.022)</td>
<td>(-0.081)</td>
</tr>
<tr>
<td>Size(t_{-1})</td>
<td>(-0.003)</td>
<td>(-0.004^*)</td>
<td>(0.001)</td>
</tr>
<tr>
<td>Rated(t_{-1}) (dummy)</td>
<td>(0.022^{**})</td>
<td>(0.000)</td>
<td>(0.0113)</td>
</tr>
<tr>
<td>Profitability(t_{-1})</td>
<td>(-0.088^{**})</td>
<td>(0.001)</td>
<td>(-0.116^{***})</td>
</tr>
<tr>
<td>Market to Book Ratio(t_{-1})</td>
<td>(-0.005)</td>
<td>(-0.004)</td>
<td>(-0.007)</td>
</tr>
<tr>
<td>Constant</td>
<td>(0.049)</td>
<td>(0.077)</td>
<td>(0.081)</td>
</tr>
<tr>
<td>Year Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>2188</td>
<td>3349</td>
<td>1871</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.026</td>
<td>0.009</td>
<td>0.030</td>
</tr>
<tr>
<td>(\Delta^{\dagger}) Change in Capital Ratio</td>
<td>(-0.581)</td>
<td>(-0.975)</td>
<td>(-0.726)</td>
</tr>
<tr>
<td>(\Delta^{\dagger}) Change in Liquidity Ratio</td>
<td>(0.153)</td>
<td>(0.100)</td>
<td>(0.223)</td>
</tr>
</tbody>
</table>

\(t\)-statistics in parentheses; \(* p < 0.10, \{** p < 0.05, *** p < 0.01\)

\(\dagger\) Cash\(t\)/(Cash\(t\) + Undrawn Credit Line\(t\)) − Cash\(t-1\)/(Cash\(t-1\) + Undrawn Credit Line\(t-1\))

\(\dagger\dagger\) Crisis − Pre-Crisis
Table 9
Ex-ante effect of shocks to bank health on high quality firms - financially unconstrained firms

<table>
<thead>
<tr>
<th>Dependent Variable:</th>
<th>LC &gt; 0</th>
<th>LC &gt; 0.05</th>
<th>LC &gt; 0.1</th>
</tr>
</thead>
<tbody>
<tr>
<td>Change in Firm Cash Ratio&lt;sup&gt;†&lt;/sup&gt;</td>
<td>(1) Crisis</td>
<td>(2) Pre-Crisis</td>
<td>(3) Crisis</td>
</tr>
<tr>
<td>Change in Lender Capital Ratio&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-6.181**</td>
<td>-0.465</td>
<td>-5.603*</td>
</tr>
<tr>
<td>(2.077) (0.529)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Change in Lender Liquidity Ratio&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-1.546***</td>
<td>-0.068</td>
<td>-1.557***</td>
</tr>
<tr>
<td>(2.910) (0.192)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lender Capital Ratio&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.729</td>
<td>0.123</td>
<td>-1.031</td>
</tr>
<tr>
<td>(-0.673) (0.126)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lender Liquidity Ratio&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>0.262</td>
<td>0.022</td>
<td>0.311</td>
</tr>
<tr>
<td>(1.403) (0.182)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lender Size&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.005</td>
<td>-0.005</td>
<td>-0.001</td>
</tr>
<tr>
<td>(0.437) (0.732)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lender Wholesale Ratio&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>0.266</td>
<td>-0.185</td>
<td>0.542</td>
</tr>
<tr>
<td>(0.541) (0.890)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lender Deposit Ratio&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>0.656</td>
<td>-0.084</td>
<td>0.861</td>
</tr>
<tr>
<td>(1.106) (0.409)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Size&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>0.003</td>
<td>0.002</td>
<td>0.009</td>
</tr>
<tr>
<td>(0.468) (0.413)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Profitability&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>-0.266*</td>
<td>0.127</td>
<td>-0.363**</td>
</tr>
<tr>
<td>(-1.842) (0.989)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Market to Book Ratio&lt;sub&gt;t-1&lt;/sub&gt;</td>
<td>0.010</td>
<td>-0.014</td>
<td>0.010</td>
</tr>
<tr>
<td>(0.734) (1.306)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Constant</td>
<td>-0.542</td>
<td>0.139</td>
<td>-0.560</td>
</tr>
<tr>
<td>(-1.355) (0.679)</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Year Effects</td>
<td>Yes</td>
<td>Yes</td>
<td>Yes</td>
</tr>
<tr>
<td>Observations</td>
<td>604</td>
<td>982</td>
<td>518</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.052</td>
<td>0.006</td>
<td>0.076</td>
</tr>
<tr>
<td>∆†† Change in Capital Ratio</td>
<td>-5.716*</td>
<td>-5.779*</td>
<td>-4.913*</td>
</tr>
<tr>
<td>(-1.845)</td>
<td>(-1.875)</td>
<td>(-1.722)</td>
<td></td>
</tr>
<tr>
<td>∆†† Change in Liquidity Ratio</td>
<td>-1.477***</td>
<td>-1.637**</td>
<td>-1.763***</td>
</tr>
<tr>
<td>(-2.313)</td>
<td>(-2.547)</td>
<td>(-3.027)</td>
<td></td>
</tr>
</tbody>
</table>

<sup>t-statistics in parentheses; * p < 0.10, ** p < 0.05, *** p < 0.01. Subsample of dividend paying firms with credit rating and asset size in the top 25%</sup>

<sup>†</sup> Cash<sub>t</sub>/Cash<sub>t</sub> + Undrawn Credit Line<sub>t-1</sub>) - Cash<sub>t-1</sub>/Cash<sub>t-1</sub> + Undrawn Credit Line<sub>t-1</sub>)

<sup>††</sup> Crisis - Pre-Crisis