Discretion and Systemic Risk in Credit-Line Contracts: Theory and Evidence.*

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Abstract

We provide evidence that credit lines are a contingent source of liquidity and, therefore, an imperfect substitute for cash holdings. We consider the role of credit line covenants in rationing scarce liquidity in the banking sector. While firms use credit lines as insurance against liquidity shocks, banks use covenants to ration scarce liquidity during systemic liquidity shocks. When liquidity is abundant banks preserve firms access to credit following a covenant violation because of reputation concerns. Consistent with the predictions of our model, covenant violations outside the recent crisis did not lead to a higher likelihood of credit-line revocations. During the credit crisis period the revocation probability for firms violating a covenant was higher by seven percent relative to non-violating firms. Banks with high credit-line reputation revoked less outside of the crisis but during the crisis they revoked similarly to banks with low reputation due to liquidity concerns.

Keywords: Systemic Risk, Financial Crisis, Liquidity, Credit Lines, Covenants, Financial Stability, Insolvency, Discretionary Contracts.

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1 Introduction

There is a common understanding as well as a body of empirical evidence confirming that in many cases covenant violations on credit line contracts do not lead to credit-line revocations.[1] This might seem at odds with the view of credit lines as liquidity insurance. Credit-line contracts are different from other debt contracts in the timing of capital transfer from creditors to firms. While, for example, in term loans the principal is transferred at origination, in credit line contracts the draw-down occurs only when the firm is in a liquidity need. Once the firm finds itself in a liquidity need, following the arguments in Holmström and Tirole [1998], it does not have enough pledgeable income to raise funds in the spot market. Therefore, the firm can only rely on liquidity insurance. Credit lines provide such liquidity insurance, where the firm pays a fee in exchange for the promise of the bank to provide the liquidity on favorable terms when needed by the firm. When the firm draws the credit line, the bank will not break even on this loan. A covenant violation offers banks a legal right not to provide liquidity and revoke the credit line access. Thus, it is puzzling to see that banks preserve access to credit lines following covenant violations.

We provide a novel explanation for why there are renegotiations and even covenant violation waivers in credit-line contracts which relies on the role of covenants in rationing scarce liquidity. In our model during normal times banks do not revoke credit lines after covenant violations because of reputation concerns. Banks have enough liquidity to satisfy the liquidity needs of all firms, and after a covenant breach we observe violation waivers. However, once there is a liquidity shortage, as in the case of a systemic shock to liquidity, banks use covenant violations as a liquidity-rationing device, and covenant violations lead to credit line revocations. We incorporate in our modeling framework an increase in deposits due to the flight to safety. It increases the liquidity available to banks, and because of the banks' reputation concerns, results in fewer credit lines cancellations following a covenant violation.

We test the predictions of our model using data on credit-line use from Capital IQ, covenant violations data from Roberts and Sufi [2009], and data on firms' fundamentals from Compustat over the sample period 2002 - 2011. Consistent with our model predictions, outside the crisis period, 2007-2009, a covenant

[1] For example, Sufi [2009] documents that in the year following the covenant violation the drop in the unused available credit for draw-down is on average only 50%, while the total credit line drops on average by only 25%. See also Acharya, Almeida, and Campello [2013], Barakova and Parthasarathy [2012], and Berrospide, Meisenzahl, and Sullivan [2012].

violation[2] was not related to an increase in the likelihood of credit-line revocation. In 2007-2008, firms violating a covenant were 7.1% more likely to lose credit line access than non-violating firms. In 2009, during the flight-to-safety inflow of deposits to banks (see Acharya and Mora [2015]), covenant violations did not increase the likelihood of revocations. Furthermore, we provide a direct test of the "reputation concerns" conjecture of our model. In order to do that, we hand-collect from the SEC regulatory filings in EDGAR the identities of the banks that extended credit lines to a representative set of firms. We then match these identities to the corresponding borrowing firms and also bank-level variables from SNL Financial. To proxy for credit-lines related reputation concerns we construct a variable that captures the amount of credit-lines business that lending banks in our sample do. Consistent with our model's predictions we find that banks' reputation concerns are the main driver of the revocation pattern that we document. In normal times, banks with higher reputation concerns revoke significantly less credit lines upon a covenant violation. However, during the 2007-2008 crisis period, these same banks increase their revocation probability by approximately 82%, consistent with the use of covenant violations as a liquidity-rationing device.

Our findings shed light on the important question — are credit lines a "guaranteed" or "safe" source of liquidity? Even though it might appear that covenant violations are often waived by banks, we provide evidence that credit lines are a *conditional* source of liquidity, and in that sense this source of liquidity is inferior to the internal cash holdings. During a severe aggregate shock, banks will exercise their right to withdraw credit lines following a covenant violation, even if during normal times they did not do so.

Our model provides a framework which can be used to analyze the effects of banks' competition on their role as liquidity providers. The regulator can influence banks' competition through the barriers to entry into the banking industry as well as through the price-setting rules of banks. In deciding to foster more competition, the regulator should consider the following two effects. More competitive banking industry would lead to credit lines with smaller premia; at the same time more competitive banks might find themselves less willing to obey discretionary contracts, since the disciplining role of the future profits through reputation is smaller. Our model highlights this trade-off and asks for a careful analysis of the potential regulatory interventions to competition between banks.

[2] We look at covenant violations of all contracts, not only directly related to credit-line contracts. That is because of cross-default provision clauses, which imply that in case a covenant is violated on any debt contract, the credit-line contract is considered to be in technical default as well (see e.g., Li, Lou, and Vasvari [2015]).

Another insight from our model is the effect of regulatory capital requirements on the structure of credit line contracts. The higher are the capital requirements, the more incentives banks have to offer discretionary contracts. This means contracts with tighter covenant thresholds, that firms are more likely to violate. With these credit-line contracts, firms face more uncertainty about the access to liquidity, which increases the costs of doing business for them. This effect is in addition to the direct effect of capital requirements on the price of loans. The regulators should consider this potential consequence in setting the required capital ratio.

Furthermore, we present empirical evidence that the liquidity insurance through credit lines is conditional on banks' health. This suggests that in times of systemic liquidity shortage additional government guarantees[3] should be put in place by the regulator to maintain the depositors' trust and provide banks with enough liquidity through the flight-to-safety inflow of deposits.

Our paper contributes to the literature that looks at the consequences of covenant violations on firm policies and behavior.[4] Chava and Roberts [2008] and Nini, Smith, and Sufi [2012] show that firms decrease their investments after a covenant violation. Furthermore, we contribute to the literature relating bank health and credit availability to non-financial firms. Huang [2010] shows that during the crisis the bank's conditions appeared to influence credit-line access in the short term. We extend his analysis by showing a particular mechanism, covenants, through which banks were able to safeguard themselves against liquidity insolvency. Berger and Udell [1992] present evidence that in periods of credit market tightness, banks still honor their credit commitments. On the other hand, Bernanke and Blinder [1988] find that a tightening of monetary policy leads to a decline in aggregate bank lending activity[5] and later studies show that this effect is more pronounced for smaller banks with less liquidity and higher leverage (Kashyap, Rajan, and Stein [1999], Kishan and Opiela [2000], Jiménez, Ongena, Peydró, and Saurina [2012]). We add to this literature by documenting the consequences of covenant violation on pre-committed lines of credit, and the strategic use of covenants as a rationing device by banks in times of abundant and scarce liquidity.

[3]For instance, the Emergency Stabilization Act of increased deposit insurance limit and the FDIC's temporary guarantee program for the newly issued senior unsecured debt of banks.

[4]See Sufi [2009], Acharya, Almeida, and Campello [2013], Barakova and Parthasarathy [2012], and Berrospide, Meisenzahl, and Sullivan [2012], among others.

[5]Other papers show that shocks to bank capital, such as political shocks and government policy changes, affect investment spending, capital structure or performance of borrowers considerably, Peek and Rosengren [2000] , Kang and Stulz [2000], Khwaja and Mian [2008], Paravisini [2008], Chava and Purnanandam [2011].

We provide a novel role for covenants in credit-line contracts. From the traditional perspective, covenants are included in a debt contract to trigger an early renegotiation of the debt (Lehar [2014]) or in credit line contracts to provide incentives for the manager to avoid risk-shifting (Acharya, Almeida, Ippolito, and Perez [2014a]). We propose a complementary role for covenants. In case of a systemic event when liquidity is not sufficient to satisfy the demand from affected firms, banks can use covenant violations to ration the scarce liquidity and avoid breaching their contractual obligations. That is, the covenants are included in credit-line contracts because of banks' solvency considerations in systemic events, and not only to make credit contingent on a firm's creditworthiness.

In our discussion of liquidity demand and the role of credit lines in mitigating the liquidity risk we follow the reasoning of Holmström and Tirole [1998]. A complementary view of liquidity demand is based on the time-limitations of investment opportunities. If investment-opportunities are short-lived, as in Martin and Santomero [1997] or more recently in Bolton, Chen, and Wang [2011], then firms would like to secure access to a credit line which provides immediate access to funds. Those motives for credit line demand do not feature a subsidy from banks to firms that a draw-down entails in a Holmström and Tirole [1998] environment, but if credit-line contracts are front-loaded through a commitment fee, upon a covenant violation the bank still has an incentive to cancel the existing credit-line contract and potentially offer a new one to collect the fee again.

Our view on the discretion in credit-line contracts is close to that of Boot, Greenbaum, and Thakor [1993]. In particular, Boot, Greenbaum, and Thakor [1993] also demonstrate that banks tradeoff financial and reputational capital in discretionary contracts, achieving a higher efficiency than with only fully enforceable contracts. The particular friction that discretion helps overcome in the setting of Boot, Greenbaum, and Thakor [1993] is asymmetric information. In contrast, in our setting the information is symmetric, while the aggregate state is not verifiable. In Boot, Greenbaum, and Thakor [1993], the main role of discretion is to allow banks to signal their type, while banks in our setting use discretion (covenants) to avoid liquidity insolvency. Despite these differences in the modeling approaches, the main message is similar. Banks offer discretionary contracts to overcome contracting frictions. The difference in terms of the predictions between the two modeling settings lies in the effects a policy of increased transparency can have. While Boot, Greenbaum, and Thakor [1993] would predict a reduction in the use of discretionary contracts, our model would

feature no change, unless the policy of increased transparency also implies more verifiable information. Moreover, in our setting, banks choose to use discretion to save on regulatory capital, so another important implication of our analysis is that with the introduction of Basel III one should expect tighter covenants in credit-line contracts.

A closely related work is Acharya, Almeida, Ippolito, and Perez [2014b]. The authors conduct a detailed empirical investigation of the consequences of credit-line covenant violations. They study banks' responses to covenant violations that include changes to interest rates, to collateral requirements, maturity of credit lines, covenants, as well as undrawn amounts. They focus on instances when following a credit-line-specific covenant violation the bank decided to do nothing, except adjust a covenant, if at all. The authors find that the financial health of banks was an important determinant of banks' decision to waive the covenant violation during the recent crisis. Our analysis differs from Acharya, Almeida, Ippolito, and Perez [2014b] in several aspects. We look at covenant violations of all contracts, not only directly related to credit-line contracts. That is because of the cross-default provision clauses, which imply that in case a covenant is violated on any debt contract, the credit-line contract is considered to be in technical default as well.[6] Moreover, we focus on "new" covenant violations,[7] because we are interested in the instances when banks obtain a legal right, which they previously did not have, to revoke a credit line.

Second, our focus is on the role that covenant violations play in the liquidity management of banks. We are interested in gathering evidence that banks use covenant violations to safeguard themselves from liquidity insolvency. While a bank's decision to increase collateral or charge a higher interest rate on credit-line loans in technical default is definitely going to affect its profitability, the immediate effect of those adjustments on its liquidity position is likely to be minimal. That is why our empirical analysis is focused on banks' adjustments to amounts available for a draw-down following a covenant violation. From our point of view, it better captures the role of covenant violations in banks' liquidity management, which is the focus of our study. While we do not observe directly the liquidity position of banks and use the crisis of 2007-2009 as a shock to the banking sector overall, the findings of Acharya, Almeida, Ippolito, and Perez [2014b] on the role of the liquidity ratio during the crisis are consistent with our model predictions. The crisis episode was characterized by a liquidity shortage and therefore a binding liquidity constraint for

[6] Li, Lou, and Vasvari [2015] report that around 95% of loan agreements contain cross-default clauses.

[7] "New" are covenant violations that were not preceded by a covenant violation in the previous financial year.

many banks. The negative change in the liquidity ratio is likely to indicate a more severely binding liquidity constraint, and therefore, a greater likelihood of credit-line revocation. We complement their empirical results by documenting the reversal of liquidity shortage in 2009, which was likely driven by flight-to-safety inflow of deposits.

Our empirical findings are also consistent with evidence on liquidity provision by banks documented by Acharya and Mora [2015]. The authors argue that in the first part of the 2007-2009 crisis the banking system was under pressure from undrawn commitments until the government intervention in the middle of 2008.[8] We show that covenant violations are associated with higher probability of credit line revocation during 2007-2008 and not in 2009.These findings are also consistent with the role of banks as liquidity providers proposed by Kashyap, Rajan, and Stein [1999]. Additional government guarantees made the relationship between the credit-line draw-down demand and the deposit draw-downs strongly negative, which increased the cost synergies of banks providing credit lines that are financed with demand deposits.

2 Model set up

We are building on the framework introduced in Holmström and Tirole [1998]. The setting will incorporate a possibility that either only idiosyncratic risks are realized, or all firms are hit with a systemic liquidity shock. The banking system is providing liquidity insurance for both scenarios, relying on internally generated liquidity as well as government securities (T-bills).

2.1 Firms

Consider an entrepreneur that is endowed with a project that lasts for 3 dates. At date 2 in case of success the project generates a cash flow of R. The probability of success depends on the effort level of the entrepreneur, and is equal to p_H if the entrepreneur exerts an effort, and p_L if not. Shirking generates a private benefit of B to the entrepreneur. At date 1 the firm can be hit with a liquidity shock ρ. Because of the moral hazard problem, the maximum pledgeable amount that the project generates is $\rho_0 = p_H(R - B/\Delta p)$. We consider $p_H R = \rho_1 > \rho > \rho_0$, which means that the entrepreneur can not raise enough funds from the capital market

[8] The FDIC's transaction account guarantee (TAG) was established in October 2008 to guarantee noninterest-bearing transaction accounts. The Emergency Economic Stabilization Act (authorized by TARP, enacted on October 3, 2008) increased the deposit insurance limit from $100,000 to $250,000.

to withstand the shock, even though it is optimal to continue. Denote by Δp the difference in success probabilities. Then the non-depletable equity stake of entrepreneur is $p_H B/\Delta p$.

2.2 Liquidity Risk

The economy consists of a unit mass of identical firms. There are two aggregate states in the economy — systemic and non-systemic. A systemic event happens with probability μ and all the firms are hit with a liquidity shock ρ. In a non-systemic event, liquidity shocks are idiosyncratic and hit λ of firms. The remaining $1-\lambda$ continue with the project without additional costs.

2.3 A Credit Line Contract

Banks offer protection against liquidity shocks. During non-systemic events, firms that are not hit with a liquidity shock can provide liquidity to those that are hit. During systemic events, this internally generated liquidity provision does not exist since all firms are hit with the shock. Therefore, the banking sector must rely on externally generated liquidity to provide liquidity insurance in systemic events. The particular mechanism we consider is government bonds. We assume, as in Holmström and Tirole [1998], that government bonds can be purchased at date 0 at a price $q > 1$ which is referred to as liquidity premium. At date 1 those bonds can be converted to cash.[9]

We consider the following credit-line contract — the banks' offer is a pair of $\{\bar{\varepsilon}, y\}$. At date 0 banks buy a quantity L of government bonds, and in case of a non-systemic event firms unaffected by idiosyncratic liquidity shocks pay a premium y to the bank.

The cut-off value $\bar{\varepsilon}$ is capturing the role of covenants. Each firm at date 1 receives an idiosyncratic signal ε that is drawn from a distribution $F(\varepsilon)$. It is uncorrelated with the risk of liquidity. The sole purpose of ε is to differentiate firms on a characteristic that is not related to liquidity demand.[10] If the realized $\varepsilon < \bar{\varepsilon}$, then the firm has violated a covenant, and provision of liquidity to such firm is at the discretion of the bank.

If the firm that was hit with a liquidity shock did not violate a covenant, then the bank is obliged to provide $\rho - \rho_0$ to the firm. The contract allows firms to raise ρ_0 from external sources, for example term

[9] An alternative source of external liquidity supply can be an inflow of deposits from households, provided households are not affected by systemic liquidity shock. This is discussed in more detail in Section 4.

[10] We can think of ε as being a period 1 income shock, and then consider a limit as the support of the distribution of ε approaches 0. That is, we can think about ε as being negligibly small to affect the overall value of the firm.

loans, effectively entirely diluting existing debt claimants, if any.

An alternative way to specify a credit-line contract would be to set the credit limit at ρ, the total liquidity need, instead of $\rho - \rho_0$, the part above the pledgeable income. In this case, the firm would not need to raise funds under a different arrangement in the amount ρ_0 this borrowing would also be a part of a credit-line draw-down. Even though in terms of the model predictions those two approaches are identical, the empirical observations suggest that credit lines are written on the amount $\rho - \rho_0$. To see this, let us have a look at the histogram of changes in the undrawn credit amount following a credit-line revocation.[11] The top left-hand corner diagram of Figure 5 illustrates that in most cases after a covenant violation the undrawn amount either falls to zero (the mass at -1) or stays nearly the same (the mass near 0). If credit-lines were written on ρ, following a covenant violation, we should have seen partial revocations as the credit-limit should have dropped to ρ_0, that is, the mass should have been more evenly spread between -1 and 0. From this we conclude that the assumption that credit lines are written on the amount $\rho - \rho_0$, while firms raise ρ_0 from other sources, is plausible. [12]

We assume that banks can not contractually condition provision of liquidity insurance on systemic/non-systemic events, as these events are not directly related to firms. This assumption is in line with the evidence documented in Ivashina and Scharfstein [2010] that "material adverse change clauses" are rarely invoked. In practice banks are explicitly excluded from revoking credit line access due to adverse changes in general economic conditions.[13] Instead, to ration limited liquidity in systemic times, banks can use financial covenants in the credit line contracts. Banks set $\bar{\varepsilon}$ such that the amount L of government bonds they acquired is exactly enough to cover the liquidity demand of $\rho - \rho_0$ of firms that are lucky and received $\varepsilon > \bar{\varepsilon}$, therefore, $1 - F(\bar{\varepsilon})$ is the mass of surviving firms in case of the systemic shock.

In the current section, we consider a contract where in case of a non-systemic event the bank exercises its right to revoke a credit line on all "unlucky" firms that violated a covenant (realised $\varepsilon < \bar{\varepsilon}$).

[11] Details about sample construction and sources of data are discussed in detail in Section 7.

[12] In the current setting we consider only $\rho > \rho_0$. This is because if $\rho < \rho_0$, the firm does not need a credit line to finance its liquidity needs, it can use its pledgeable income to obtain a term-loan or issue bonds. In this latter case in case the firm has violated a covenant, it can survive the liquidity shock by renegotiating a credit-line contract into a term loan of an amount up to ρ_0. In a more general case, the firm can be hit with either of those shocks - above or below ρ_0. We consider this setting explicitly in the Appendix, and demonstrate that the main findings of the paper still hold: covenants can still be used to ration liquidity in systemic events, and banks' reputation allows them to offer discretionary credit line contracts that result in no revocation after a covenant violation in normal times.

[13] We discuss this assumption in more detail in Section 5.

2.4 Entrepreneurs' Profit

The entrepreneur has to make a choice — to sign up for a credit line or not. We assume that the entrepreneur is risk-neutral. His expected profit as of date 0 in case of no credit line contract (his reservation value) is

$$H_0 = \mu[0] + (1-\mu)[\lambda(0) + (1-\lambda)(p_H R)] \tag{1}$$

If the entrepreneur buys insurance against liquidity shocks through a credit line $\{\bar{\varepsilon}, y\}$, the expected profit as of date 0 is

$$H(\bar{\varepsilon}, y) = \mu\left[(1-F(\bar{\varepsilon}))p_H \frac{B}{\Delta p}\right] + (1-\mu)\left[\lambda(1-F(\bar{\varepsilon}))p_H \frac{B}{\Delta p} + (1-\lambda)(p_H R - y)\right] \tag{2}$$

The credit-line contract is feasible if the firm can pay y in case it is not affected by a liquidity shock. In other words,

$$y \leq \rho_0 \tag{3}$$

By signing a credit line agreement, a firm is purchasing insurance against adverse states when it is hit with a liquidity shock at the expense of a decrease in expected profit in states where it is not hit with a liquidity shock.

2.5 Banks' Profit

In order to provide liquidity in case of the systemic shock, the bank has to buy bonds to cover the liquidity demand $\rho - \rho_0$ coming from "lucky" firms that are of mass $1 - F(\bar{\varepsilon})$:

$$L = (1-F(\bar{\varepsilon}))(\rho - \rho_0) \tag{4}$$

The bank cannot buy less than the specified amount because then it would not be able to fulfill the contractual obligations, and it will not buy more bonds than necessary because of the liquidity premium at which bonds are traded ($q > 1$). In the current setting, therefore, there is a one-to-one relationship between $\bar{\varepsilon}$ and L.

In case of a non-systemic event the bank provides liquidity insurance as specified in the credit line contract only to lucky firms that do not violate the covenants.

$$\pi(\bar{\varepsilon}, y) = -qL + \mu[0] + (1-\mu)[L + (1-\lambda)y - \lambda(1-F(\bar{\varepsilon}))(\rho - \rho_0)] \tag{5}$$

The bank gets to keep L bonds in case there is no systemic event. Moreover, it collects the credit-line premium y from the non-affected firms, and provides liquidity only to "lucky" firms.

2.6 Equilibrium Contracts

The relative bargaining power of the firms and the banking sector will determine how the surplus generated by the provision of liquidity insurance is split between banks and firms. Let us first determine contracts that are feasible and admissible for both banks and firms. Recall the relationship between $\bar{\varepsilon}$ and L and re-write

$$\begin{aligned} H(L,y) &= \mu\left[\frac{L}{\rho-\rho_0} p_H \frac{B}{\Delta p}\right] + (1-\mu)\left[\lambda \frac{L}{\rho-\rho_0} p_H \frac{B}{\Delta p} + (1-\lambda)(p_H R - y)\right] \\ &= (\mu + (1-\mu)\lambda)\frac{L}{\rho-\rho_0} p_H \frac{B}{\Delta p} + (1-\mu)(1-\lambda)(p_H R - y) \qquad (6) \\ \widetilde{H(L,y)} &= H(L,y) - H_0 \\ &= (\mu + (1-\mu)\lambda)\frac{L}{\rho-\rho_0} p_H \frac{B}{\Delta p} - (1-\mu)(1-\lambda)y \qquad (7) \end{aligned}$$

$$\begin{aligned} \pi(L,y) &= -qL + (1-\mu)\left[L + (1-\lambda)y - \lambda \frac{L}{\rho-\rho_0}(\rho-\rho_0)\right] \\ &= L[(1-\mu)(1-\lambda) - q] + (1-\mu)(1-\lambda)y \qquad (8) \end{aligned}$$

A feasible contract $\{L, y\}$ is such that

$$y \leq \rho_0$$

A contract is admissible if $\widetilde{H(L,y)} \geq 0$ and $\pi(L,y) \geq 0$. Moreover, since $q > 1$, firms will never find

it optimal to demand $L > \rho - \rho_0$. The contracts that satisfy these criteria are illustrated graphically by the shaded area in Figure 1.

The linear nature of the objective functions leads to the corner solutions. We consider the environment such that firms have all the bargaining power and banks break even on each contract. The reason we focus on this particular distribution of the bargaining power will become entirely clear in the next section. Anticipating the set-up of the next section, the best contract that banks without reputation can offer to firms is the one where banks break even and firms collect the generated surplus. The level of expected profit that this contract can give to entrepreneurs is the minimum that banks with reputation have to offer to firms to compete with banks without reputation.

Three cases of parameter constellations are possible. In the first, rudimentary case, the liquidity premium q is too high, and firms choose to buy no liquidity protection. In the other two cases firms purchase as much liquidity insurance as possible. They either are able to purchase the full protection and demand $L^* = \rho - \rho_0$. In that case the bank provides guaranteed protection, covenants play no role and there is no notion of scarce liquidity in the event of a systemic shock. Alternatively, if the moral-hazard problem is severe, firms run out of pledgeable funds and settle for $L^* < \rho - \rho_0$ with $y^* = \rho_0$. The latter case is of primary interest because it involves partial liquidations and liquidity-rationing through covenants. Because of the one-shot nature of the contract, the bank will also revoke the access to credit lines of firms that violated covenants in case of no systemic event. All cases are illustrated in Figure 2.

In what follows, we will focus on a parameter set such that the equilibrium contract in the environment with full firms' bargaining power offers partial insurance (case 3):

Assumption 1.

$$\frac{q-(1-\mu)}{1-(1-\mu)} < \frac{p_H B/\Delta p}{\rho - \rho_0}$$

Assumption 2.

$$\frac{q-(1-\mu)(1-\lambda)}{(1-\mu)(1-\lambda)} > \frac{\rho_0}{\rho - \rho_0}$$

Formally this result is stated in the following proposition:

Proposition 1. *If Assumptions 1 and 2 are satisfied, the equilibrium contract that maximizes the profit of*

the entrepreneur subject to the break-even condition of the bank is $\{L^*, y^*\}$ *s.t.*

$$\begin{aligned} L^* &= \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0, \\ y^* &= \rho_0. \end{aligned}$$

Moreover, $L^* < \rho - \rho_0$.

Although the resulting equilibrium contract $\{L^*, y^*\}$ generates surplus, it is not efficient. The unlucky firm's willingness to pay for the liquidity provision in case of an idiosyncratic liquidity shock is $p_H B/\Delta p$, which is $(1-\mu)\lambda F(\bar{\varepsilon}) p_H B/\Delta p$ in expected terms a priori. The cost of liquidity provision for the bank in this state is $(1-\mu)\lambda F(\bar{\varepsilon})(\rho - \rho_0)$. Since

$$\rho_1 > \rho > \rho_0 \Rightarrow \rho_1 - \rho_0 = p_H B/\Delta p > \rho - \rho_0 \tag{9}$$

that is, firms can pay more than it costs for the bank to provide insurance for the unlucky firms hit with idiosyncratic liquidity shock.

Note that q does not play a role here because in case of no systemic shock, the bank has enough internal liquidity (y collected from non-affected firms) to provide liquidity for all the affected firms, lucky or unlucky.

3 Bank Reputation

We start by considering the case that the bank cannot write covenants conditional on the aggregate state. We discuss the validity of this assumption later in Section 5. For now we assume that the covenants that are used to ration liquidity in the systemic event are going to be applicable in the non-systemic event as well. In the 3-date setting considered above the promise of the bank not to revoke the credit line if covenants are violated in case of a non-systemic event is not credible. Ex-post, the bank is saving $(\rho - \rho_0)F(\bar{\varepsilon})$ in case it revokes the credit lines for unlucky firms. And importantly, doing so does not violate contractual obligations of the bank. One way to implement the contract that allows for liquidity provision to unlucky firms in the case of a non-systemic event is through a bank's reputation. Consider a variation of the setting above where an infinitely-lived bank is facing (non-overlapping) generations of investment projects (firms). In each period

t a 3-step game as described above is played. Even though each period the new generation of firms is born, the information about the bank's actions from the previous period(s) is known. Assume that the per-period discount rate of the bank is r.

In this setting it is possible to find a contract that implicitly guarantees liquidity insurance to unlucky firms in the non-systemic state. In order to demonstrate that, we will start with the best possible contract that the bank without reputation can offer to firms and modify it in such a way that firms are indifferent, while the bank can earn a positive expected profit. The future stream of this expected profit will deter the bank from damaging its reputation today by not honoring the implicit guarantee of liquidity provision to firms violating covenants in a non-systemic event.

3.1 Contract with an implicit guarantee

The contract with the implicit guarantee for a non-systemic event delivers the following expected level of profit to the entrepreneurs:

$$\begin{aligned} H'(L,y) &= \mu\left[\frac{L}{\rho-\rho_0}p_H\frac{B}{\Delta p}\right]+(1-\mu)\left[\lambda p_H\frac{B}{\Delta p}+(1-\lambda)(p_H R-y)\right] \\ \widetilde{H'(L,y)} &= H'(L,y)-H_0 \\ &= \mu\left[\frac{L}{\rho-\rho_0}p_H\frac{B}{\Delta p}\right]+(1-\mu)\left[\lambda p_H\frac{B}{\Delta p}-(1-\lambda)y\right]. \end{aligned} \tag{10}$$

And the expected level of profit to the bank:

$$\begin{aligned} \pi'(L,y) &= -qL+(1-\mu)\left[L+(1-\lambda)y-\lambda(\rho-\rho_0)\right] \\ &= (1-\mu-q)L+(1-\mu)\left[(1-\lambda)y-\lambda(\rho-\rho_0)\right]. \end{aligned} \tag{11}$$

The trigger strategy that is followed by all generations of firms is such that if the bank in period t does not provide liquidity to unlucky firms affected by shocks in case of a non-systemic event, in the future periods it is abandoned by all subsequent generations of firms.[14] The bank loses its reputation and joins the ranks of

[14]The alternative for the bank is to offer a contract without implicit guarantee, as was discussed in the previous section. Since this contract is not efficient, banks offering contracts with implicit guarantee can attract all the firms by under-pricing the deviant

banks without reputation. To insure that it is in the interest of the bank to fulfill the implicit guarantee, the following should be satisfied:

$$\frac{\pi'(L,y)}{r} > \lambda F(\bar{\varepsilon})(\rho - \rho_0) \tag{12}$$

where the LHS of the expression above is the payoff in case the bank continues operation consistent with an implicit liquidity guarantee, while the RHS is the payoff to the deviation strategy.

3.2 Competition from banks without reputation

As long as banks with reputation receive an expected positive profit from each credit line contract, they are better off attracting as much business as possible. Since banks without reputation can offer only inefficient contracts, the banks with reputation can under-cut the banks without reputation to attract the entrepreneurs. And they will find it optimal to do so. In what follows, we construct a contract that banks with reputation can offer that will leave banks without reputation out of business.

Consider the best contract that the bank without a reputation can offer to firms: That is, the best contract with covenants and without an implicit guarantee, according to which unlucky firms in a non-systemic event are denied access to a credit line. According to Proposition 1, this contract is $\{L^*, y^*\}$, such that $y^* = \rho_0$ and $L^* < \rho - \rho_0$.

Denote by $\{L^{**}, y^*\}$ with $y^* = \rho_0$ the contract with an implicit guarantee such that firms are indifferent between $\{L^{**}, y^*\}$ and $\{L^*, y^*\}$. In states of the world when firms are not hit with a liquidity shock (systemic or idiosyncratic), firms in both contracts pay $y^* = \rho_0$, the only difference between the two contract being in the survival probabilities given the shock. Equating the two, we arrive at the following equation:

$$(1-\mu)\lambda \frac{L^*}{\rho - \rho_0} + \mu \frac{L^*}{\rho - \rho_0} \quad = \quad (1-\mu)\lambda + \mu \frac{L^{**}}{\rho - \rho_0}. \tag{13}$$

Because the contract with implicit guarantee offers liquidity protection in a non-systemic event, the bank can offer smaller survival probability in the case of a systemic event without making firms worse off. That

banks. Therefore, those banks deviating from the strategy of providing implicit insurance will be left with a reservation profit of 0.

is, $L^{**} < L^*$.

$$L^{**} = L^* - \frac{1-\mu}{\mu}\lambda(\rho-\rho_0)\left(1-\frac{L^*}{\rho-\rho_0}\right). \tag{14}$$

Recall that liquidity provision in case of a systemic event is more expensive for the bank than liquidity provision in case of a non-systemic event. Therefore, the profit of the bank from the contract $\{L^{**}, y^*\}$ with an implicit guarantee is higher than the profit of the bank from the contract $\{L^*, y^*\}$ without an implicit guarantee (which is zero):

$$\begin{aligned}
\pi'(L^{**}, y^*) - \pi(L^*, y^*) &= -qL^{**} + (1-\mu)[L^{**} + (1-\lambda)y^* - \lambda(\rho-\rho_0)] \\
&\quad -\Big(-qL^* + (1-\mu)\left[L^* + (1-\lambda)y^* - \lambda\frac{L^*}{\rho-\rho_0}(\rho-\rho_0)\right]\Big), \\
&= \left[\frac{q-1}{\mu}\right](1-\mu)\lambda(\rho-\rho_0)\left(1-\frac{L^*}{\rho-\rho_0}\right).
\end{aligned} \tag{15}$$

The larger the liquidity premium, the more savings the bank can expect by offering the contract $\{L^{**}, y^*\}$ with an implicit guarantee of protection in case of a non-systemic event relative to the contract $\{L^*, y^*\}$ without implicit guarantee.

As long as the time-discount rate of the bank is not too high, the bank's dominant strategy would be to provide liquidity in a non-systemic event even to firms that violated covenants.

Proposition 2. *If Assumptions 1 and 2 are satisfied and additionally we assume that banks with reputation have bargaining power over firms, then*

1. *if $r \leq \bar{r}$, the banks with reputation will offer $\{L^{**}, y^*\}$, where*

$$\begin{aligned}
L^{**} &= L^* - \frac{1-\mu}{\mu}\lambda(\rho-\rho_0)\left(1-\frac{L^*}{\rho-\rho_0}\right), \\
y^* &= \rho_0, \\
\bar{r} &= \frac{\pi(L^{**}, y^*)}{\lambda(\rho-\rho_0)\left[1-\frac{L^{**}}{\rho-\rho_0}\right]}.
\end{aligned}$$

and in equilibrium there would be no banks without reputation.

2. *if $r > \bar{r}$, there would be only banks without reputation operating in equilibrium and they will offer contracts $\{L^*, y^*\}$ as defined in Proposition 1.*

In the discussion above we assumed that banks that have a reputation have the bargaining power over firms. That is, the contract $\{L^{**}, y^*\}$ offers improvement in efficiency over the contract $\{L^*, y^*\}$ and all the additional surplus accrues to banks. This assumption can be relaxed and competition among the banks with reputation can be introduced. In that case, for a given r, the competition will drive L up so that $L^{**} < L < L^*$ and a part of the surplus that is beyond what is necessary to ensure compliance of banks will accrue to firms. In that case, banks will be indifferent between honoring the implicit guarantee and not in case of a non-systemic event for firms violating covenants.

4 Demand Deposits

In this section we examine the role of demand deposits as a liquidity source for banks. As argued by Acharya and Mora [2015], demand deposits play a big role in banks' ability to serve as liquidity providers. According to the authors, the current crisis was special because it did not see a flight-to-safety-driven increase in demand deposits of banks until a government intervention in mid. 2008. We discuss the role of demand deposits and of flight-to-safety in the design of the credit-line contract.

4.1 Demand Deposits

Denote by M_0 the net inflow of new demand deposits that the bank can draw on during the non-systemic event. This is the extra liquidity that flows to the bank at date 1 from deposits, if any.[15] This liquidity is not required to be transferred in time from date 0 to date 1, and therefore, does not trigger the liquidity premium.

[15] One could think of the benchmark case $M_0 = 0$. In that case the bank expects the inflow of new deposits to exactly compensate for whatever withdrawals that might happen. If the bank expects positive growth in its deposits, then $M_0 > 0$.

During a systemic event, the bank will have M of liquid assets from deposits, where

$$M = \begin{cases} M_+ & \text{with probability } p_+, \\ M_0 & \text{with probability } 1 - p_+. \end{cases} \tag{16}$$

With $p_+ = 0$ we have a setting where demand deposits are not affected by the systemic event. The setting with $p_+ > 0$ would correspond to a 'flight-to-safety' situation that Acharya and Mora [2015], among others, refer to. The idea behind the flight-to-safety phenomenon is the decision of depositors to transfer resources from risky assets affected by the systemic shock to banks that are perceived to be safe because of the government guarantee.

During normal times, the bank can cover liquidity demand from an affected firm from a few sources: first of all, the sale of government bonds, then fees y collected from unaffected firms, and then the net inflow of deposits M_0. During a systemic event, the bank can rely only on the proceeds from the sale of government bonds and on the net inflow of deposits, if any. The liquidity that is coming from the sale of government bonds, costs to the bank q , while the liquidity that is coming from the net inflow of deposits costs 1, since it is contemporaneous.

Given that the bank in the current setting can count on extra M of funds in crisis and M_0 outside the systemic event, what do the equilibrium contracts look like?

4.2 No-reputation bank's contract

In case of a systemic event, the bank has two sources of liquidity — government bonds L and the demand deposits M, and it uses these funds to cover the demand from affected firms that did not violate covenants.

$$L + M = (1 - F(\bar{\varepsilon}))(\rho - \rho_0).$$

Therefore, the survival probability in case of systemic event is given by $\frac{L+M}{\rho-\rho_0}$. If the bank in case of a systemic event ends up with a liquidity amount that is less than what it is contractually obliged to provide, it is safe to assume that it will lose its reputation and the continuation business. Such a bank would face fines for violating contractual obligations. The case could be made that such a bank would lose a license, or

look for an extremely expensive government rescue, which will still lead to the loss of reputation. In order to avoid violating its contractual obligations, the bank will set $\bar{\varepsilon}$ — the tightness of covenants, so that:

$$1 - F(\bar{\varepsilon}) = \frac{L + M_0}{\rho - \rho_0}. \tag{17}$$

In case the flight-to-safety scenario is realized, the bank without reputation will not allocate the additional liquidity to save an extra portion of the firms that violated liquidity. Therefore, the entrepreneurs can count on being saved only when they do not violate the covenant, and that is exactly $1 - F(\bar{\varepsilon})$, independent of the flight-to-quality situation.

Objective functions of the entrepreneur and the bank are:

$$\begin{aligned} \widetilde{H^D(L,y)} &= H^D(L,y) - H_0 \\ &= (\mu + (1-\mu)\lambda)\frac{L+M_0}{\rho-\rho_0} p_H \frac{B}{\Delta p} - (1-\mu)(1-\lambda)y \end{aligned} \tag{18}$$

$$\begin{aligned} \pi^D(L,y) &= -qL - M_0 + (1-\mu)\left[L + M_0 + (1-\lambda)y - \lambda\frac{L+M_0}{\rho-\rho_0}(\rho-\rho_0)\right] \\ &= L[(1-\mu)(1-\lambda) - q] + (1-\mu)(1-\lambda)y - M_0(\mu + (1-\mu)\lambda) \end{aligned} \tag{19}$$

Proposition 3. *If Assumption 1 is satisfied, and*

$$\frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0 - \frac{q-1}{q-(1-\mu)(1-\lambda)}M_0 < \rho - \rho_0,$$

which is an analog of Assumption 2, then the contract that the banks without reputation will offer to entrepreneurs is $\{L_D^*, y^*\}$*, where*

$$\begin{aligned} L_D^* &= \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0 - \frac{1-(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}M_0, \\ y^* &= \rho_0. \end{aligned}$$

Notice that $L^* > L_D^*$, meaning that given the supply of liquidity from depositors, banks need to buy fewer government bonds.

4.3 Contract with an implicit guarantee

Under Assumptions 1 and 2, the most efficient contract offers as much protection to firms as they can pay for with their pledgeable income ρ_0. The most protection in the case with demand deposits and potential flight-to-safety would mean that covenants are set using M_0:

$$1 - F(\bar{\varepsilon}) = \frac{L + M_0}{\rho - \rho_0},$$

but banks excuse covenant violations for an extra $\frac{M-M_0}{\rho-\rho_0}$ mass of firms, that is in addition to the discretionary protection to firms violating covenants in case of a non-systemic event. Therefore, the offered contract is discretionary in two cases - in case of a systemic event that was characterized by the flight-to-quality for a small mass of firms that violated a covenant, and in case of a non-systemic event for all firms that violated covenants.

Proposition 4. *If Assumption 1 is satisfied, as well as*

i) $\frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0 - \frac{q-1}{q-(1-\mu)(1-\lambda)}M_0 < \rho - \rho_0$,

ii) banks with reputation have a bargaining power over firms,

then the following equilibria are possible:

1. *if $r < \bar{r}_D$, then the banks without reputation have a zero share of business, banks with reputation offer $\{L_D^{**}, y^*\}$.*

2. *if $r > \bar{r}_D$, then banks without reputation cover the full market by offering contracts $\{L_D^*, y^*\}$ as described in Proposition 3.*

Expressions for L_D^{**} and $\bar{r}_D$ can be found in the Appendix.

For the parameter constellation described above we observe an equilibrium that is similar to what we have described before in a setting without demand deposits. Banks with reputation offer discretionary

contracts to firms and preserve their reputation by providing liquidity in states where firms' willingness to pay for protection a priori is higher than the cost of providing liquidity. Banks with reputation enjoy bargaining power over firms and take all the surplus generated by the improvements in efficiency over the non-discretionary contracts that banks without reputation can offer.

One interesting feature of the observed equilibrium is that the larger the expected inflow of funds due to flight-to-safety, the more discretionary the credit-line contract is. In the systemic event, firms expect to be saved even in case they have violated the covenant.

In the discussion above, the information about M is symmetric, while one can think of the consequences of a delay in transmission of this information to the markets. If subsequent generations of firms have access to the correct information, then the reputation mechanism will keep incentives of the bank aligned with that of the current generation of entrepreneurs. Therefore, a delay in information transmission would not qualitatively alter the equilibrium. Since deposits are non-risky liabilities, there is little room for disagreement with respect to their measurement and valuation. It seems unlikely that the information about M would be transmitted with an error. In other words, banks offer discretionary contracts, even when the information about the underlying state is symmetric and verifiable. The discretionary nature of the contract allows them to save on regulatory capital. This result complements that of Boot, Greenbaum, and Thakor [1993], which rests on the assumption that information about the underlying state is non-verifiable.

In the on-set of a systemic event, according to the equilibrium above, not all firms are expected to be saved. In case $L_D^{**} + M_+ \geq \rho - \rho_0$, that is, the additional inflow of deposits due to the flight-to-safety phenomenon is sufficient to cover the liquidity demand from all firms, banks are pressured by the threat to their reputation to save all firms that violated the covenant. But since there is uncertainty with respect to whether flight-to-safety will actually happen, banks include covenants in credit line contracts and guarantee liquidity with purchase of government bonds only for the mass of firms that will not violate a covenant. Depending on the severity of the crisis, we could observe the bank revoking access to credit lines to firms violating a covenant, or forgiving the covenant violations and preserving the access.

4.4 A Negative Shock to Bank's Liquidity

The case when the bank experiences an outflow of liquidity instead of an inflow is also plausible. That is, it might be the case that a bank will find itself in the situation where $M = M_{-} < M_0$. That scenario would be consistent with a negative supply shock to the bank's liquidity, a capital crunch.

We do not model it explicitly, but the implications of this possibility are clear — the chance of a negative shock to the internal liquidity of the bank will ask for higher holdings of government bonds, making credit-line insurance more costly. This will lead to tighter covenant thresholds and smaller protection that is available to firms in systemic events. So the equilibrium credit-line contract will resemble that of $\{L_D^{**}, \rho_0\}$, except with a higher L, and higher implied $\bar{\varepsilon}$, so that banks buy more bonds, but they set the covenant thresholds high to protect themselves in the worst possible scenario. This contract features discretion in the systemic event, just like the contract $\{L_D^{**}, \rho_0\}$. If the negative shock was not realized, some firms that violated a covenant could expect to be saved since the bank's liquidity constraint is not binding when only non-violating firms are saved.

A possibility of a negative liquidity shock to the bank's liquidity would amplify the effect of the systemic event — a simultaneous liquidity shock to all firms. The more likely such a shock is to happen, the more pronounced the role of the covenants to safeguard banks from insolvency in systemic events will be, and the more discretionary the offered credit-line contracts are.

5 Aggregate State - observable but not verifiable

The assumption that banks cannot write contracts conditional on systemic events is crucial to the analysis. In the environment where banks could write such contracts, the efficient contract would feature covenants that are applicable only in a systemic event. This contract would have no need for implicit guarantees. And a bank's reputation would play no role.

This assumption is in line with previous work on the role of banks' reputation, (for example, see Boot, Greenbaum, and Thakor [1993]). One way to implement the conditioning on the systemic shock would be to condition covenants on the state of the balance sheet of the bank. This opens up the channel of asymmetric information — entrepreneurs and regulations clearly know less about the bank's balance sheet than the bank

itself.

The recent financial crisis illustrated the opacity of the banking system clearly. If the exposure to the systemic risk, including the risk of liquidity, could have been established clearly and reliably, the government would not need to revert to bail-outs. An alternative to the discount window source of liquidity provision was established during the crisis to minimize the effect of stigma associated with borrowing from the Fed (see Armantier, Ghysels, Sarkar, and Shrader [2015]). These events are the evidence that there is asymmetry of information regarding the quality of banks' assets. And while it might be the case that sophisticated investors have the ability to gather the right information, their ability to verify it and write contracts on it is questionable.

We would like to offer yet another perspective on this assumption.

5.1 The Role of Regulatory Capital

Discretionary contracts are indeed very popular in practice, and have been in the spotlight of the recent discussion on regulatory reforms related to Basel III requirements. The degree of discretion the bank has in fulfilling the contract is factored into the calculation of the required regulatory capital. For example, in the calculation of the liquidity coverage ratio, the contracts that merely indicate intention to do business enter with the coefficient of zero. That is, they do not require any regulatory capital to be posted against them. On the other side of the spectrum are the committed liquidity facilities to other financial institutions that have a coefficient of 100%, so that for every committed dollar under such a contract the bank has to hold a dollar of capital. Credit line contracts to non-financial firms would be somewhere in between along that spectrum. The presence of covenants makes the contracts more discretionary and therefore the bank would be required to post less regulatory capital against those contracts.

Thus the discretionary nature of the credit line contract with covenants allows banks to potentially save on the amount of regulatory capital. Therefore, if they are faced with choice of a contract with implicit guarantee and the contract that makes covenants explicitly conditional on the systemic event, the banks would choose the more discretionary first option.

In other words, even if banks were given the choice of making covenants conditional on a systemic event or not, the banks would prefer the less-explicit more-discretionary contract with unconditional covenants.

A related question is: if banks prefer discretionary contracts to non-discretionary ones with the same effective state of obligations, would they then offer contracts that are even more discretionary than considered in Section 3.1? The savings from holding less regulatory capital have to be balanced against the costs of sustaining the contract with implicit guarantee. The larger the discretion implicit in the contract, the larger the profit from deviation, and therefore, the more reputational capital the bank needs to have to sustain such a contract. Consider a modified version of equation 12:

$$\frac{\pi(L,y)}{r} > \text{Deviation Profit} \tag{20}$$

The discretion of the contract positively affects deviation profit as well as per-period profit from sustaining the reputation through savings on regulatory capital. As long as the sensitivity of per-period profit is smaller than the sensitivity of the deviation profit with respect to discretion of the credit-line contract, there is a unique maximum sustainable amount of discretion that will naturally limit the choice of contracts that the bank can offer.

5.2 Bank run

An alternative way to make covenant thresholds state-contingent would be to write them on a generally-observable macro-variable. While the covenants would be less precise in preventing the financial distress for a particular bank in systemic events, since presumably banks have different exposures to it, there is another concern with this approach. If the macro-variable is approaching a threshold after which there would be a change in the covenants, the firm that is at risk of violating a covenant after the change will have all the incentives to (mis)report the liquidity shock now and withdraw funds. That would constitute a credit-line run on the bank, which might spill over to deposits.

The three arguments that we provide in this section support our assumption that aggregate stat is observable (potentially with noise), but not verifiable. Now we proceed to the empirical implications of our analysis.

6 Hypothesis

Building on the set-up of the previous sections, we propose the following hypothesis for testing. The first hypothesis follows from the observation that outside the crisis banks do not revoke access to a credit line to firms that violated a covenant because of reputation concerns. They have enough internal liquidity to satisfy this demand. This is implied by the optimal discretionary contract $\{L_D^{**}, y^*\}$ as described in Proposition 4.

Hypothesis 1. *Most of firms that violate a covenant outside a crisis period are expected to preserve their access to a credit line.*

We formulate the hypothesis using the term "most" since in reality there could be other reasons why banks include covenants in their credit line contracts, complementary to the role of rationing scarce liquidity that we have discussed in this paper.

The discretionary contract $\{L_D^{**}, y^*\}$ also implies that the systemic event is the time when liquidity is scarce and covenant violations are used to ration it. Therefore, firms that violate covenants in crisis should see their access to a credit line revoked. Considering that there are other reasons behind the inclusion of covenants, we formulate the hypothesis relative to the non-crisis period.

Hypothesis 2. *Banks are more likely to revoke access to a credit line of the firm that violated a covenant during the crisis rather than outside a liquidity crisis.*

The fact that a covenant violation in crisis does not necessarily lead to the revocation of the credit line is consistent with the discretionary contract $\{L_D^{**}, y^*\}$. Banks could use an inflow of deposits to fund the demand from the firms that violated a covenant. The more inflow of deposits to the banking sector we observe, the fever revocations due to covenant violations we should observe. This is the next hypothesis that we test.

Hypothesis 3. *If banks experience a flight-to-safety driven inflow of deposit funds during a crisis, they are more likely to preserve the access to a credit line for a firm that has violated a covenant than if they do not experience the inflow.*

7 Empirical Analysis

7.1 Sample construction

We obtain firm-level data for the period 2002-2011 from Capital IQ and Compustat. Our dataset contains U.S. firms covered by both data providers. Following Acharya, Almeida, Ippolito, and Perez [2014a] we focus on companies traded on AMEX, NASDAQ and NYSE. We further remove utilities (SIC 4900-4999) and financial companies (SIC 6000-6999). Besides, we remove companies with negative or missing assets and revenue. We obtain a sample of 28,368 firm-years with 3,830 unique firms. Because of missing data on a variety of Compustat items, we often employ a smaller sample in our analysis.

Capital IQ collects information on corporate debt capital structure by going through the financial footnotes in firm's 10-K SEC filings. Important for our analysis, they provide detailed information on the drawn and the undrawn portions of companies' credit lines. Based on this information we construct a dummy variable for credit line revocations. We add data on covenant violations presented in Roberts and Sufi [2009]. [16] This data set contains all financial covenant violations without specifying the type of debt contract the violated covenant is written upon. The data is extracted from the SEC filings, which are mandatory under SEC Regulation S-X. Ideally, for our analysis we would have had data on covenant violations relating to the specific credit line contract. The data that we have does not allow us to tell whether a company has violated a covenant on e.g. its term loan, credit line or public debt, which in turn might confound our tests. However, this concern is mitigated by the existence of cross-default provisions in most credit line agreements (Beatty, Liao, and Weber [2012]). These provisions ensure that the violation of a covenant in e.g. a public debt contract automatically puts the borrower in a default on its private debt as well. Accordingly, we construct a covenant violation dummy equal to one, if a new violation occurs (i.e. there is a covenant violation in t but not in period t-1) and zero otherwise. In addition, following Acharya, Almeida, Ippolito, and Perez [2014a], we compute a set of variables, such as profitability, size, leverage, tangibility, market to book, cash, net working capital, capex, research and development expenses, dividend payer dummy, and cash flow volatility. (See Table 3 in the Appendix for an exact definition of the variables. Finally, we examine the

[16] We thank Michael Roberts for making these data available on his website.

distribution of each constructed variable and correct for outliers accordingly. [17]

7.2 Credit lines demand during the 2007-2009 financial crisis

The focus of our study is on credit lines, since they are a widely present form of corporate borrowing. Companies usually secure a credit line facility to fulfill short-term liquidity needs, as well as to hedge themselves against realizations of future bad states with less liquidity supply. The recent 2007-2009 credit crisis was exactly such a realization, characterized by an increased demand for credit lines by firms, but not enough supply by banks.

Berrospide, Meisenzahl, and Sullivan [2012] present evidence that for the period of the recent crisis credit line drawdowns increased by almost 100%. There was a continuously increasing demand throughout the whole crisis period, with firms starting to draw on their credit line facilities as early as in the first half of 2007. In addition, although credit line demand continuously increased throughout the crisis period, credit lines availability declined (e.g. figure 5 Berrospide, Meisenzahl, and Sullivan [2012]). This evidence is in line with the evidence presented by Ivashina and Scharfstein [2010]. They also document that during the crisis period firms increased their drawdowns in response to growing concerns about their access to credit. Moreover, they show that there is a substantial supply effect coming from banks cutting down on new loans, and even more so for banks with less access to deposit financing.

On the whole, firms relied on credit lines to withstand the recent 2007-2009 financial crisis. This resulted in an increased demand for credit lines but not enough supply. This period presents an ideal laboratory for us to test some of the main predictions of our model, namely that banks are more likely to revoke access to a credit line for firms that violated a covenant during the crisis rather than outside a crisis period due to liquidity shortage, and this effect was mainly contained in the period with less access to deposit financing.

[17] We trim variables with outliers at 1% in both tails of the distribution.

7.3 The 2007-2008 versus the 2009 crisis period

In this subsection we explain our rationale for splitting the period of the recent 2007-2009 financial crisis in two sub-periods: 2007-2008 and 2009.

The traditional view is that banks can easily provide liquidity in bad times. This view suggests that in the presence of market stress the increased demand for bank funds, e.g. for pre-committed credit lines, is offset by the supply of funds usually coming from the deposits' side of bank's balance sheet. This is mainly due to the so-called flight to safety effect, i.e. there is a deposit guarantee from the government in place (see e.g. Gatev and Strahan [2006]).

However, the 2007-2008 crisis period was characterized by severe distrust in the banking system and increased demand for credit, which resulted in not enough liquidity in the banking system to be distributed to liquidity-demanding firms. As noted by many previous papers (e.g. Acharya, Schnabl, and Suarez [2013] and Diamond and Rajan [2009]), banks' insolvency was threatened by holdings of toxic assets, which in turn scared a lot of investors and depositors. This resulted in banks experiencing severe liquidity distress. Acharya and Mora [2015] argue that until government interventions at the end of 2008, banks' role as liquidity providers through deposit inflows was severely impaired. Because most of the deposits exceeded the deposit insurance limit at the outset of the 2007-2009 crisis, investors preferred to hold assets with explicit government guarantee (e.g. such as treasury securities, directly or through money market funds). Indeed, Acharya and Mora [2015] show that until the end of 2008 investors (households) seeking safety amassed into securities issued or sponsored by the government and not into deposits or bank debt.[18] However, at the end of 2008 the situation changed. After the Lehman bankruptcy and the subsequent failure of the Reserve Primary Fund [19] there was a huge outflow from primary funds. These funds were relocated to a larger extent to the banking sector in the form of deposits. This is mainly due to the following events happening at the end of 2008 and in 2009: First, the Federal Reserve liquidity facilities were introduced. Second, the Emergency

[18] For example the increase in prime money market funds, one of the main vehicles through which investors hold treasuries in the U.S., was more than 100% during the onset of the crisis.

[19] The Reserve Primary Fund had a huge exposure to Lehman and its net asset value fell below one dollar, "breaking the buck" on September 16, 2008.

Stabilization Act increased the deposit insurance limit from USD 100,000 to USD 250,000 per depositor. Third, the FDIC announced a temporary program, guaranteeing the newly issued senior unsecured debt of banks as well as non-interest bearing deposit transaction accounts largely held by companies. These measures, together with other implicit guarantees, resulted in deposits flowing back into the banking sector and allowed the banking system to close the loan-demand-to-liquidity-supply gap that was created during the 2007-2008 period (see e.g. Table 2 and Figure 4 of Acharya and Mora [2015]).

In light of all the above-mentioned events, we concentrate on the 2007-2008 crisis period. This period was characterized by both a positive credit lines demand shock coming from firms and banks not having enough liquidity to satisfy firms' demand. We apply this shock to test the main prediction of our model, namely, that banks ration scarce liquidity in the presence of a systemic shock and covenant violations through exercising their right of credit revocation. Moreover, we concentrate on 2009 as a period characterized by flight-to-safety deposit inflows to test the next important prediction of our model, namely that if banks have enough liquidity to satisfy firms' demand, they are more likely to preserve the access to a credit line for a firm that has violated a covenant.

7.4 Covenant Violations

The next important question for our analysis is whether the covenant violation dummy should be contemporaneous or lagged. Using a lagged covenant violation dummy has the advantage of clear out-of-sample prediction. However, this comes at the cost of potentially low power of the tests, i.e. economically speaking, if banks revoke credit lines at the moment of covenant violation we might not be able to find anything if we allow for a one-year difference between the covenant violation and the credit line revocation in our model specification. The alternative is to use a contemporaneous covenant violation dummy (as in e.g. Nini, Smith, and Sufi [2012]). We decided to infer the right time period for the covenant violation dummy from the data. We use the following baseline estimation framework, where we allow for up to five lags of the covenant violation dummy [20]:

[20] For a similar procedure see Roberts and Sufi [2009].

$$Revocation_{i,t} = \alpha_i + \sum_{n=0}^{5} \beta_{n+1} Violation_{i,t-n} + \varepsilon_{i,t} \tag{21}$$

Where: $Revocation_{i,t}$ is a dummy variable equal to one if there was a revocation during the past one year and zero otherwise. The construction of this dummy variable is similar to Acharya, Almeida, Ippolito, and Perez [2014a]. We consider a revocation to occur in period t when a firm has a positive amount of undrawn credit in period $t-1$ and none in period t, and the increase in drawn credit lines is smaller than the decrease in undrawn credit lines.[21] We employ a probit model. $Violation_{i,t}$ is the covenant violation dummy equal to one if a new violation occurs and zero otherwise. The time subscripts go from t to $t-5$ denoting the different time lags.

The results from this estimation are presented in table 5. The findings indicate that only the coefficient of the contemporaneous covenant violation dummy is statistically significantly related to the probability of credit line revocation. We therefore concentrate, for all further estimations, on the contemporaneous covenant violation dummy.

7.5 Model Specification

In this section we outline our main model specification. To test the hypothesis of our theory, we limit the sample to firms that have credit lines in period $t-1$ and in period t. We use the following baseline estimation framework:

$$\begin{aligned} Revocation_{i,t} = {} & \beta_1 Crisis_{2007-2008} \times Violation_{i,t} + \beta_2 Crisis_{2009} \times Violation_{i,t} + \beta_3 Violation_{i,t} \\ & + \beta_4 Crisis_{2007-2008} + \beta_5 Crisis_{2009} + \gamma X_{i,t-1} + \alpha_j + \rho_r + \mu_e + \varepsilon_{i,t} \end{aligned} \tag{22}$$

Where: $Revocation_{i,t}$ is a dummy variable equal to one if there was a revocation during the past year and zero otherwise. We employ a probit (marginal effects dF/dx) model, which is estimated with industry, rating and trading exchange fixed effects, α_j, ρ_r, μ_e respectively. As a proxy for the liquidity shock we

[21] Our definition of credit line revocation allows for an increase in the drawn credit lines amount from $t-1$ to t, as long as the increase in the drawn amount is smaller than the decrease in the undrawn amount. This is in contrast to the definition of Acharya, Almeida, Ippolito, and Perez [2014a], which requires that the drawn portion does not increase.

apply the first part of the recent 2007-2009 credit crisis ($\text{Crisis}_{2007-2008}$) and as a proxy of times with a flight-to-safety of demand deposits we use year 2009 of the recent crisis period (Crisis_{2009}). $Violation_{i,t}$ is the covenant violation dummy equal to one if a new violation occurs and zero otherwise. The main terms of interest are the interaction terms between the the covenant violation dummy and the crisis dummies ($Crisis_{2007-2008} \times Violation_{i,t}$ and $Crisis_{2009} \times Violation_{i,t}$). The controls $X_{i,t-1}$, include profitability, size, leverage, tangibility, market to book, cash, net working capital, capex, research and development expenses, dividend payer dummy, cash flow volatility and long-term debt maturing in one, two, three, four and five years. To reflect the fact that the relation between controls and the revocation probability might be different during the distinct crisis periods we also perform an estimation that includes interaction terms of all controls and crisis dummies (Controlls x Crisis (07-08/09) interactions). For all estimations we report robust standard errors clustered at the firm level (Petersen [2009]).

8 Analysis and Results

8.1 Descriptive Statistics

We start our analysis with a discussion of the descriptive evidence presented in table 3 and figure 3. The total number of covenant violations remains relatively constant over time with a decrease in the last two years of the sample. However, the share of credit line revocations among the firms that violate a covenant experiences a sharp increase at the onset of the financial crisis, year 2007 (17%) and year 2008 (18%) as compared to the pre-crisis years 2005(9%) and year 2006(7%)[22]. This evidence is in line with the model prediction that banks are more likely to revoke the access to a credit line of the firm that violated a covenant during the liquidity crisis rather than outside the crisis. In contrast to the 2007-2008 period, year 2009 indicates a strong reversal in the revocation trend. The share of credit line revocations among the firms that violate a covenant drops to 3%. This evidence is in line with the model prediction that if banks experience an inflow of deposit funds (e.g. due to flight-to-safety reasons) and therefore have more liquidity to distribute

[22]The share of credit line revocations among the firms that violate a covenant in year 2004 is 19%. We attribute this effect to a potential data error resulting from the abnormally low number of covenant violations in that year (26 covenant violations in year 2004 as compared to an average of 35 covenant violations for all other pre-crisis years).

to firms, they are more likely to extend the access to a credit line for a firm that has violated a covenant. On the whole, this evidence presents initial, uni-variate support for the main predictions of our theory. In the next section we provide further results from multivariate tests of our hypothesis.

8.2 Drawn Credit Lines around Covenant Violation

An important question for our analysis is whether covenant violations occur when firms are in liquidity need, and, therefore, whether firms draw down on credit lines near the violation events. In this section we discuss graphical evidence presented in Figure 4. In order to clearly identify the effect of a violation on drawn amounts, we require that the company does not experience another violation in the five-year window around the event, i.e. from two years before the covenant violation to two years after the violation the company experience only one covenant violation indicated in the figure by period zero. Moreover, we require the firms to be present in the sample for the entire 5-year interval.[23] To further refine our analysis we distinguish between two important groups of companies, companies that do not experience a revocation upon covenant violation and companies that experience a revocation.

The evidence for the companies that experience a revocation indicates that one period before the violation they increase their drawn credit lines amount. This is in line with the intuition that these companies are in a liquidity need and probably rationally expect the reduction in drawn credit lines in the next period and therefore increase their liquidity buffer one period in advance. Upon a covenant violation these same companies experience a sharp decline in their drawn credit lines, which is likely the result of the revocation and other actions of the bank including potentially the shortening of maturity. One period afterwards they increase the drawn portion again. Recall that we consider only firms that survived at least two years following the violation, so the sample naturally includes only the firms that successfully found financing sources, which is reflected in the increase in the draw-down amount.

The pattern for the companies that do not experience a revocation is almost reversed: one period before the violation they only slightly increase their drawn credit lines amount. Upon a covenant violation these companies draw down on their credit lines, indicating that they have a liquidity need, which they satisfy through a draw-down because the bank does not revoke credit-line access.

[23] While the analysis in the figure concentrates on a subsample, the regression analysis beginning in the next section examines all violations.

Opposite to the behavior of the companies that experience the revocation, those that do not experience the revocation decrease their drawn credit lines in the period after the violation. This evidence suggests that either their need for high liquidity is over, or that the banks apply to these firms some of the other instruments, such as increasing fees or collateral requirements, which in turn makes it relatively more expensive for these companies to use lines of credit relative to other sources of liquidity funding.

8.3 Model Results

The estimation results for the relation between a covenant violation and a credit line revocation are presented in this section. We start the discussion by going through the hypothesis implied by our theoretical framework, as presented in Subsection 6.

The first hypothesis suggests that if a company violates a covenant in times with no systemic liquidity shock, banks would be more likely to renegotiate the credit line contract and even excuse the covenant violation by the firm, due to their own reputation concerns. Accordingly, we expect that β_3 from equation 22 to be statistically indistinguishable from zero. Consistent with our first hypothesis, columns three and four of table 6 show that the coefficient of the dummy variable for new covenant violation is statistically insignificant. It is important to notice that in the absence of variables that control for the financial conditions of the companies, the coefficient of the dummy variable for new covenant violations is also positive and statistically significant as shown in column one of table 6. This evidence is in line with the traditional view that covenants proxy for the overall financial condition of the company, with most likely companies of bad condition violating a covenant more frequently. This effect naturally disappears once we control for all the relevant variables capturing the financial condition of the company, as shown in columns three and four.[24] These results imply that, indeed, companies that violate a covenant in periods characterized by abundant liquidity do not experience a higher chance of credit line revocation, as compared to companies that do not violate a covenant.

[24] As a robustness check, we re-estimate the model using a constant sample. Results are reported in table 8. Once firms with missing information on controls are eliminated, even the model without controls (see column 1) indicates that a covenant violation dummy is not a relevant statistic outside a crisis period. This result can potentially be attributed to the fact that requiring firms to have information on the controls eliminates poor performing companies that struggled with reporting to the regulatory authorities, hence, missing accounting information.

We next turn our attention to the second hypothesis, namely that banks are more likely to revoke access to a credit line facility for firms that violated a covenant during times of severe liquidity tightness. As already discussed in subsection 7.3, we use the first part of the 2007-2009 period as a proxy for a period characterized by banks having not enough liquidity to meet firms' credit demand. We expect β_1 from equation 22 to be positive and statistically significant.

Consistent with the second hypothesis, columns three and four of table 6 show that the coefficient of the interaction term between the dummy variable for new covenant violation and the dummy variable for the 2007-2008 period is positive and statistically significant.[25] In addition, the coefficient of the dummy variable for the 2007-2008 period is positive and statistically significant as well. In particular the 2007-2008 crisis period is associated with a 1.5% higher probability of credit line revocation for non-violators, as compared to the period outside the crisis. Furthermore, companies that violate a covenant during the 2007-2008 period experience an additional 7.1% increase in the probability of a credit line revocation over and above non-violators during the same period. In total, the probability of a credit line revocation for companies that violate a covenant during the crisis, conditional of fundamentals, increases by 7.5% as compared to the period outside the crisis. This evidence is in line with the reasoning that once we control for the fact that covenants proxy for the overall financial condition of the company, in crisis covenant violations serve another purpose, namely they are mainly used as a rationing device by liquidity-constraint banks.

It might also be that the revocation dummy variable captures not only a credit line revocation from the bank's side but also a decrease in credit demand from the company's side. For example, companies might voluntarily decrease their undrawn credit lines amount outstanding simply because of no future need and cost-saving arguments. We therefore perform our test also on a sub-sample containing only covenant violators. By constraining the sample to covenant violators, we hope to better capture the revocations that are mainly driven by banks' decisions (i.e. non-voluntary decrease in credit lines availability). The results

[25] The magnitude of the interaction effect in nonlinear models does not always equal the marginal effect of the interaction term, and can also be of the opposite sign (Ai and Norton 2003). To address this concern and to estimate the right magnitude and standard errors of the marginal effect of the interaction term we follow Karaca-Mandic, Norton, and Dowd 2012 and apply the Stata *margins* command. Furthermore, we estimate the model on sub-samples concentrating either only on covenant violators (results presented in table 7) or on different estimation periods (2007-2008 vs. 2009 vs. Outside of Crisis - results presented in table 9). Estimating the model on sub-samples allows us to separately estimate the β_1 and β_2 coefficients without relying on interaction terms, which, in turn, alleviates the potential bias discussed in Karaca-Mandic, Norton, and Dowd 2012. The magnitude and the coefficient signs are in line with the main estimation, supporting the validity of our results.

are presented in table 7. Still, the dummy variable for the 2007-2008 period is positive and statistically significant. Overall, these findings confirm our model prediction that in the event of a systemic shock, overall liquidity demand from firms increases, and banks use covenant violations as a rationing mechanism of liquidity provision, i.e. banks have less liquidity at hand, and therefore they revoke the credit lines for companies violating a covenant.

We next test the third hypothesis, namely that when banks experience a "flight-to-safety" driven inflow of deposit funds during the crisis, they are more likely to preserve the access to a credit line for a firm that violated a covenant, as compared to a time when the banks do not experience a capital(deposits) inflow. We use year 2009 as a proxy for such a period of capital abundance. As already mentioned in subsection 7.3, year 2009 was characterized by the relocation of funds to the banking sector in the form of deposits. This relocation was mainly driven by the introduction of the Federal Reserve liquidity facilities, the Emergency Stabilization Act and the temporary guarantees provided by the FDIC. We therefore expect β_2 from equation 22 to be statistically insignificant. Consistent with the third hypothesis, columns three and four of table 6 show that the coefficient of the interaction term between the dummy variable for new covenant violation and the dummy variable for the 2009 period is statistically not different from zero. In addition, the coefficient of the dummy variable for the 2009 period is negative and statistically significant. This evidence is in line with the flight-to-safety hypothesis and indicates that both violators and non-violators, conditional on fundamentals, had the same chance of credit line revocation during the year of 2009. The evidence also suggests that the probability of revocation for both groups decreased by approximately 3% as compared to periods outside the crisis and by 4% as compared to the 2007-2008 period. In 2009 the decrease in the probability of revocation for violators was approximately 10% as compared to the probability of revocation for violators during the 2007-2008 period. This evidence is also consistent with the results presented in table 7. On the whole, these findings lend support to our prediction that banks use an inflow of deposits to fund the demand from the firms that violated a covenant. The more inflow of deposits to the banking sector we observe, the lower the likelihood that a bank will revoke a credit facility due to a covenant violation.

Overall, the results lend strong support to the model predictions. In addition, the coefficient signs of

the control variables are in line with the existing literature (see e.g. Acharya, Almeida, Ippolito, and Perez [2014a]).

9 Reputation of Banks

In order to investigate if the pattern of credit-line revocations that we document is indeed driven by the bank's concern about reputation, we perform a further analysis in which we gather information about the firms' banks. We hand-collect the identities of the banks that extended credit lines to the firms in our sample of 184 admissible firm-year violations.[26] We have used the SEC regulatory filings in the EDGAR data base to identify the names of the lenders. We were able to identify the lender names for 174 firm-year observation. Furthermore, we matched these names to findamentals data from SNL Financial. Interestingly, the majority of the credit-line contracts are provided by one lender although there are instances of syndicated lending. In total we have 152 unique firms and 53 unique financial institutions in our sample.[27]

The data suggests that some banks tend to do much more credit lines business than others as documented in table 10. The top four banks with the largest number of credit-line contracts that we observe have 55% of all the credit lines in our sample. Other banks extend substantially fewer credit lines, which suggests to us that probably the credit-line business is less important for these bank in terms of future profit generation.

The next step is to construct a proxy for bank's reputation in the credit-line business segment. We therefore group banks into two groups — banks in Group 1 appear in our sample more than once and hence are more active in credit lines lending, and banks in Group 2 appear only once in our sample. We see the banks in Group 1 as those corresponding to banks with reputation in our theoretical model and banks in Group 2 to those without reputation. Despite the limitations of using the realized frequency of covenant violations as the proxy of the importance of the credit line business segment in the portfolio of bank business, this is the best empirical proxy we have found so far. [28]

Table 11 presents descriptive evidence of the revocation pattern for Group 1 and Group 2 firms outside

[26]This is the sample of firm-year covenant violations for which we have Capital IQ data on credit-line use and also Compustat data on firm fundamentals as in table 7 columnt 3.

[27]For the syndicated loans we have averaged the banks' variables. Results are also robust if we use instead only the fundamental information for the biggest lender in the syndicate.

[28]This proxy might also capture the propensity of banks to lend to more risky firms. To take this concern into account, in table 12 we present evidence of multivariate tests, in which we explicitly control for firm's riskiness as well as other important firm fundamentals.

and during the crisis. It is important to notice that the credit lines of firms in Group 1 during the crisis were revoked in almost 18% of the cases, while outside of crisis in only about 4% of the cases, which constitutes an increase in the revocation probability by a factor of 4.5. For the Group 2 companies the situation is very different and revocation probabilities in and out of the crisis are much more similar - they differ only by a factor of 1.6. Moreover, the revocation probability outside of the crisis for companies in Group 1 is only 3.96%, which is significantly lower than the 12.5% revocation probability for companies in Group 2. This evidence suggests that banks that care about their reputation for doing business in the credit-line business segment revoke significantly less outside of the crisis, but revoke similarly to banks without reputation during the crisis.

To verify that the unconditional evidence presented above is not driven by systematic differences in firm or bank fundamentals, we study the effect of bank reputation on revocation probabilities in a multivariate regression setting. We construct a dummy variable, *Lender Reputation*, which takes the value of one if a company is in Group 1 (i.e., the company is borrowing from a bank that lends credit lines more than once) and zero if the company is in Group 2. We augment our main estimation specification, as described in section 7.5, by adding additional bank-level variables and corresponding interaction terms with the crisis period. The bank-level variables are the capital ratio, the liquidity ratio, bank size, the deposits ratio, the non-performing loans and bank age (see definitions in Table 1). We estimate the probit model of revocation probability as a function of the crisis dummy variable, the lender reputation dummy, their interaction as well as firm-level and bank level control variables. The estimation results are presented in table 12. The coefficient estimates in column 1 re-iterate a previously observed pattern that revocation probabilities were significantly higher in the 2007-2008 crisis period and that banks with higher reputation are less likely to revoke the credit line by 8.6% than banks without reputation concerns. The estimation results in column 4 are the main results regarding the effect of bank reputation concerns on the revocation probability. The coefficient estimate on crisis 2007-2008 dummy is capturing the difference between the revocation probabilities for banks without reputation in and out of crisis. It is statistically insignificant, consistent with the model prediction that banks without reputation offer non-discretionary contracts, and the revocation probabilities in such a contract do not depend on the aggregate state and therefore we should not see a difference between in and out of the crisis periods. The coefficient estimate on the reputation dummy captures the difference

between the revocation probabilities of banks with and without reputation in the period outside of crisis. It is negative and statistically significant, consistent with the model prediction that banks with reputation concerns offer more discretionary contracts and revoke fewer credit lines outside of the crisis. The effect is economically significant — banks with reputation have almost 13% lower revocation probability than banks without reputation outside of the crisis. The interaction term between the lender reputation dummy and the crisis dummy indicates the difference between the revocation probabilities of the firms with reputation concerns in and out of the crisis. It is positive and statistically significant. This result is consistent with the model predictions that banks with reputation increased revocation probabilities during the crisis. We estimate that the effect is 81.5%.

The additional bank-level variables that we include in the regression specification take into account potential confounding effects coming from differences in banks' lending and borrowing structure, banks size, age, as well as liquidity and capitalization positions on the credit-line revocation probabilities. The inclusion of these bank variables sheds light also on the potential effects of bank regulation on the credit line revocation probabilities. We find that outside of the crisis neither the capital ratio of the bank nor the liquidity ratio have any effects on the revocation probability. During the crisis though, higher capital ratios were associated with a lower revocation probability, consistent with findings of Acharya, Almeida, Ippolito, and Perez [2014b]. The liquidity ratio has a statistically significant positive effect on the revocation probability during the crisis. This finding is consistent with banks that revoked more credit lines having higher liquidity ratios during the crisis, simply because they were lending less. Therefore, a bank regulation targeting a minimum level of liquidity ratio throughout crisis events might potentially have a negative consequences to credit lending banks, because this type of regulation gives banks the incentive to revoke credit lines as a way to achieve the desired liquidity ratio.

10 Examples of Covenant Violations

In order to illustrate that banks are indeed better off revoking a credit line after the firm has violated a covenant, we look in detail at three instances of covenant violations outside of the crisis. In all three cases the banks did not revoke the credit line, while they had a legal right to do so. Yet we estimate that the profit on the credit line that the banks earned in each case was negative.

The first case is the company Carrizo Oil and Gas Inc. In 2004 the company violated a minimum current ratio covenant in its credit facility agreement with Hibernia National Bank and Union Bank of California, N.A. The applicable draw-down fee on the credit line as part of the credit facility was the Eurodollar rate plus 2%. The 1-month Eurodollar deposit rate in November 2004 was 2.23%, which yields a draw-down fee of 4.23%. The parent companies for the two banks are Hibernia Corporation and MUFG Union Bank. The cost of borrowing for Hibernia Corporation in 2004 was 2.71%. To arrive at the cost of maintaining the credit line for the bank, we add to the cost of borrowing the proportional overhead expenses related to running bank's operations. We observe that the ratio of non-interest expenses[29] to the sum of total interest and non-interest income in 2004 was around 45%. We interpret it as that for Hibernia on average 45% of the income it earned went to cover the non-interest expenses[30]. Therefore, we estimate the break-even cost for Hibernia to be 2.71%+0.45*4.23%=4.61%. The second bank, MUFG Union bank, had costs of borrowing of 1.77% and a fraction of non-interest expense to total income of 54%. Therefore, we estimate the break-even cost for MUFG to be 4.05%. Then we calculate either simple average of the break-even costs (4.33%) or loans-weighted average to take into account that MUFG Union Bank is the bigger bank in terms of lending (the weights are 35% and 65%, correspondingly) and obtain 4.25%. We observe that the revenue from the draw-down fee is slightly below the average cost of doing operations for the two banks.

The second case is Perficient, Inc., a computer programming services company, that in 2003 was in violation of 'certain' covenants on its revolving credit agreement. The draw-down fee for the credit line was 6.75%. The bank behind the credit line was the Silicon Valley Bank, with SVB Financial being the parent company. The cost of borrowing for it in 2003 was 2.42%, while the fraction of non-interest expense in the total income was 95%, which makes the break-even cost for the bank to be 8.82%, way above the draw-down fee.

The third case is the Quantum Fuel Systems Technologies Worldwide, Inc., which in 2006 violated a tangible net worth covenant on its revolving credit facility agreement with Comerica Bank. The draw-down fee on this line of credit was 7% before the violation, and increased to 8.75% after the violation. Comerica Bank reported costs of borrowing in 2006 to be 5.38% and the ratio of non-interest expenses to the total

[29]Non-interest expense includes the total of salaries and employee benefits, expenses of premisses and fixed assets, and other non-interest expense.

[30]Here we make the assumption that both interest income and non-interest income both generate overhead expenses of 45%.

income of 39%. Therefore, we estimate the break-even cost for the bank to be 8.78%, which is above the draw-down fee even after the increase.

It is important to note that the events of covenant violation often indicate that the default risk of the violating firm has increased, even though credit lines are typically collateralized with assets and receivables. This argument is in addition to the role of covenant violations that we have discussed so far, which was to safeguard banks from liquidity insolvency. The higher default risk would imply that the draw-down fees, that were adequate for the level of risk prior to the covenant violation, are too low following the violation. Moreover, by not revoking the credit line the bank allows the firm to continue drawing down on the unused credit line portion. By increasing the drawn amount, the firm increases the bank's exposure to its solvency risk, and exacerbates this risk at the same time by increasing its leverage. Therefore, an expected draw-down fee income, that incorporates the probability of successful repayment and the cost of the draw-down option, is lower than the reported draw-down fee. We therefore conclude that our case studies present a conservative estimate of the negative profit that banks earn on their credit lines after a covenant violation.

Our analysis presented above is subject to a few limitations. First of all, in the SNL data set we do not observe the cost of capital for the bank. We use the cost of borrowing because we believe that it is close to the marginal cost of funds for the bank. In the ideal case, we would have liked to observe the weighted average cost of capital, incorporating the cost of equity as well as the cost of deposits. The second assumption we make is about the costs of running business for the bank. The cost of borrowed funds is to be combined with non-interest expenses if the bank profit is to be calculated. We have made an attempt to calculate the average overhead expense that a dollar of revenue should earn to keep the bank profitable. The first best would have been to either observe the marginal non-interest expense coming from this particular credit line, or the alternative investment return with the same level of risk that the bank can earn. Given that our estimates of the break-even costs are quite close to the draw-down fees in the credit-line contracts, we are confident that these products are not the money-making items in the loan portfolios of the banks. Overall, these case studies lend support to the assumption that when firms violate covenants banks are not breaking even on the credit lines contracts.

11 Conclusion

There is a common understanding as well as a body of empirical evidence confirming that in many cases covenant violations are not related to credit line revocations. This is puzzling because when the firm draws the credit line, the bank will not break even on this loan. Credit line contracts are different from other debt contracts in that they serve the purpose of liquidity insurance for firms. Once the firm is liquidity-constrained, following the arguments in Holmström and Tirole [1998], it does not have enough pledgeable income to raise funds in the spot market. Therefore, the firm can only rely on the liquidity insurance provided through the prearranged credit line contract. A covenant violation offers banks the legal right not to provide liquidity and revoke credit line access. Therefore, it is puzzling to see that banks preserve access to credit-lines following covenant violations.

We rationalize the puzzling evidence of banks preserving the access to credit-lines following covenant violations, by means of a novel role of covenants – as a rationing device in times of systemic shock to banks' own liquidity. In our model banks do not revoke the access to credit during non-systemic liquidity shock periods because of concerns for their reputation. However, in times of an adverse systemic shock to banks' liquidity, banks find it optimal to revoke credit line access to firms that violate a covenant due to concerns regarding banks' own liquidity solvency. We incorporate in our model a flight-to-safety deposits increase in the liquidity available to banks, which results in banks revoking less upon covenant violation due to reputation concerns. We test the predictions of our model in a difference-in-differences setting using a large panel of U.S. non-financial firms with access to credit lines. We use the 2007-2008 financial crisis period as a natural experiment representing a period with increased demand for credit lines by firms, but not enough supply by banks due to a shock to their liquidity. We also use year 2009 of the financial crisis as a period characterized by significant flight-to-safety deposit inflows to banks and on increase in their liquidity positions. In the data we find support to our model's predictions: Firms violating a covenant in 2007-2008, had a significantly higher probability of losing their credit line access than firms violating a covenant outside the crisis period. In 2009 covenant violations did not increase the likelihood of credit line revocations.

Our findings shed light on the important question — are credit lines a "guaranteed" or a "safe" source

of liquidity? Even though it might appear that covenant violations are often waived by banks, we provide evidence that credit lines are a *conditional* source of liquidity, and in that sense this source of liquidity is inferior to internal cash holdings. During a severe aggregate liquidity shock, banks will exercise their right to reduce credit lines access to firms following a covenant violation, even if during normal times they did not do so.

APPENDIX

Proof of Propostion 1: There are contracts that deliver $\pi \geq 0$ and $\widetilde{H} \geq 0$ that are non-trivial (not $\{0,0\}$) only when the slope of the $\pi = 0$ iso-profit line is larger than the slope of $\widetilde{H} = 0$ iso-profit line of the entrepreneur. For banks, the slope is

$$\frac{\partial L}{\partial y_{\pi}} = \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}$$

For entrepreneurs:

$$\frac{\partial L}{\partial y_{\widetilde{H}}} = \frac{(1-\mu)(1-\lambda)}{1-(1-\mu)(1-\lambda)} \frac{\rho-\rho_0}{p_H \frac{B}{\Delta P}}$$

Therefore, $\frac{\partial L}{\partial y_{\pi}} > \frac{\partial L}{\partial y_{\widetilde{H}}}$ when:

$$\begin{aligned}
\frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)} &> \frac{(1-\mu)(1-\lambda)}{1-(1-\mu)(1-\lambda)} \frac{\rho-\rho_0}{p_H \frac{B}{\Delta P}} \\
\frac{1-(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)} &> \frac{\rho-\rho_0}{p_H \frac{B}{\Delta P}} \\
\frac{q-(1-\mu)(1-\lambda)}{1-(1-\mu)(1-\lambda)} &< \frac{p_H \frac{B}{\Delta P}}{\rho-\rho_0}.
\end{aligned}$$

Recall that Assumption 1 ensures that

$$\frac{q-(1-\mu)}{1-(1-\mu)} < \frac{p_H \frac{B}{\Delta P}}{\rho-\rho_0}.$$

Denote by $\gamma = (1-\mu)(1-\lambda)$. Then $\left(\frac{q-\gamma}{1-\gamma}\right)'_{\gamma} > 0$, therefore:

$$\frac{q-(1-\mu)}{1-(1-\mu)} > \frac{q-(1-\mu)(1-\lambda)}{1-(1-\mu)(1-\lambda)}$$

and combined with Assumption 1:

$$\frac{p_H \frac{B}{\Delta P}}{\rho-\rho_0} > \frac{q-(1-\mu)}{1-(1-\mu)} > \frac{q-(1-\mu)(1-\lambda)}{1-(1-\mu)(1-\lambda)},$$

so the slope of the bank's iso-profit line is larger than the slope of the entreprenur's iso-profit line.

For q-values sufficiently close to 1 it could be possible for the bank to offer a credit-line contract with

full insurance, that is, with $L = \rho - \rho_0$. This type of contract would require no covenants to be included as there would be no states with limited liquidity which is to be rationed between firms. Therefore, we focus on the case when at the maximum of their payment capacity, firms can't buy full insurance. We evaluate the implicit function $L(y)$ defined by $\pi = 0$ at $y = \rho_0$:

$$\frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0 < \rho - \rho_0$$

This condition is satisfied by Assumption 2.

Because of the linear nature of the objective functions, the equilibrium contracts would be corner-solutions. We consider a setting in which all bargaining power is in entrepreneurs' hands, in equilibrium the bank will break even. Since Assumption 1 insures that the internal cost of an extra dollar of insurance for banks is higher than for firms, firms would prefer to purchase as much insurance as they can. Assumption 2 insures that they can't purchase full insurance, so they settle for the maximum they can buy. L^* is found setting $\pi = 0$ for $y^* = \rho_0$. That is:

$$\begin{aligned} L^* &= \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0, \\ y^* &= \rho_0. \end{aligned}$$

□

Proof of Propostion 2:

Banks with reputation in setting the terms of the contract that they offer to firms take the $\widetilde{H'(L,y)} = \widetilde{H(L^*,y^*)}$ as a 'budget-constraint'. That is because of potential competition from banks without reputation, the banks with reputation can attract business if they offer to firms at least $\widetilde{H(L^*,y^*)}$ in utility level. The objective function of the bank $\pi'(L,y)$ is linear and, therefore, the optimum is in the corner. Assumption 1 ensures that the optimal solution is to offer maximal protection to entrepreneurs and charge a maximum fee equal to their pledgeable income. To see this, notice that banks want to offer protection when the slope of their iso-profit line is steeper than that of the entrepreneurs. The slopes for the bank and firms are, correspondingly:

$$\frac{\partial L}{\partial y}_{\pi'} = \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)}$$

$$\frac{\partial L}{\partial y}_{\widetilde{H'}} = \frac{(1-\mu)(1-\lambda)}{1-(1-\mu)} \frac{\rho-\rho_0}{p_H \frac{B}{\Delta P}}$$

And by Assumption 1:

$$\frac{p_H B/\Delta p}{\rho-\rho_0} > \frac{q-(1-\mu)}{1-(1-\mu)}$$

$$\frac{1}{q-(1-\mu)} > \frac{\rho-\rho_0}{p_H B/\Delta p} \frac{1}{1-(1-\mu)}$$

$$\frac{(1-\mu)(1-\lambda)}{q-(1-\mu)} > \frac{(1-\mu)(1-\lambda)}{1-(1-\mu)} \frac{\rho-\rho_0}{p_H \frac{B}{\Delta P}}$$

Therefore, banks maximize their profit by offering a contract with $y^* = \rho_0$ and the level of protection in systemic events L^{**} that delivers the same level of utility to entrepreneurs as contract $\{L^*, y^*\}$ without an implicit guarantee. $L^* *$ is determined by the following condition:

$$\widetilde{H(L^*, y^*)} = \widetilde{H'(L^{**}, y^*)}.$$

$$L^{**} = L^* - \frac{1-\mu}{\mu} \lambda(\rho-\rho_0) \left(1 - \frac{L^*}{\rho-\rho_0}\right)$$

If a bank with reputation that is offering a contract $\{L^{**}, y^*\}$ deviates in period without systemic shock and revokes access to a credit line of firms that violated the covenant, its deviation profit is $\lambda(\rho-\rho_0)\left[1-\frac{L^{**}}{\rho-\rho_0}\right]$. As long as this profit is below the expected profit from continuing operations, $\frac{\pi'(L^{**},y^*)}{r}$, there are only banks with reputation in equilibrium. The threshold level of the discount rate that can still support the equilibrium with reputation is:

$$\lambda(\rho-\rho_0)\left[1-\frac{L^{**}}{\rho-\rho_0}\right] = \frac{\pi'(L^{**}, y^*)}{\bar{r}},$$

$$\bar{r} = \frac{\pi'(L^{**}, y^*)}{\lambda(\rho-\rho_0)\left[1-\frac{L^{**}}{\rho-\rho_0}\right]}.$$

□

Proof of Proposition 3: The proof of this Proposition follows the line of the proof of Proposition 1. Assumption 1 ensures that there are credit-line contracts that are beneficial for both banks and entrepreneurs. To ensure the role of covenants, at the maximum ability to pay of entrepreneurs the banks can only offer

partial liquidity insurance in systemic events. This is the case when the second assumption in Proposition 3 is satisfied. To see this, consider the following. Evaluating an iso-profit line of a bank that corresponds to a break-even condition at $y = \rho_0$ we get:

$$\begin{aligned}
[-q+(1-\mu)(1-\lambda)](L+M_0)+(1-\mu)(1-\lambda)\rho_0+M_0(q-1) &= 0, \\
[q-(1-\mu)(1-\lambda)](L+M_0) &= (1-\mu)(1-\lambda)\rho_0+M_0(q-1),
\end{aligned}$$

$$L+M_0 = \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0+\frac{q-1}{q-(1-\mu)(1-\lambda)}M_0.$$

The total liquidity available to firms in a systemic event is $L+M_0$, and for covenants to have a role, this liquidity should be below the total liquidity demand, $\rho-\rho_0$.

$$\rho-\rho_0 > \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0+\frac{q-1}{q-(1-\mu)(1-\lambda)}M_0.$$

Then banks without reputation offer a contract $\{L_D^*, y^*\}$ such that it delivers the maximum liquidity protection in systemic events that firms can afford with their pledgeable income. The full surplus relative to the no-credit-line case accrues to firms. This is the preferred contract by entrepreneurs.

$$\begin{aligned}
L_D^* &= \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0-\frac{1-(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}M_0, \\
y^* &= \rho_0.
\end{aligned}$$

□

Proof of Proposition 4: The logic of the proof follows that of Proposition 2. We start by writing objective functions of banks with reputation and entrepreneurs, and then proceed by constructing a contract that offers firms the same default probability as contract $\{L_D^*, y^*\}$, but with full insurance in non-systemic events and additional protection in case of flight-to-safety.

L_D^{**} is defined implicitly by the following equation:

$$(1-\mu)\lambda\frac{L_D^*+M_0}{\rho-\rho_0}+\mu\frac{L_D^*+M_0}{\rho-\rho_0}=(1-\mu)\lambda+\mu\left[p_+\min\left(\frac{L_D^{**}+M_+}{\rho-\rho_0},1\right)+(1-p_+)\frac{L_D^{**}+M_0}{\rho-\rho_0}\right] \quad \text{(A-1)}$$

Depending on the underlying parameters, there are two possible solutions:

$$L_D^{**}=\begin{cases}-M_0+\frac{(1-\mu)\lambda+\mu}{\mu(1-p_+)}(L_D^*+M_0)+\frac{(1-\mu)\lambda+\mu p_+}{\mu(1-p_+)}(\rho-\rho_0) & \text{if } A\geq 0\\ L_D^*-\frac{(1-\mu)\lambda}{\mu}(\rho-\rho_0)\left(1-\frac{L_D^*+M_0}{\rho-\rho_0}\right)-p_+(M_+-M_0) & \text{if } A<0\end{cases}$$

where

$$A=-M_0+\frac{(1-\mu)\lambda+\mu}{\mu(1-p_+)}(L_D^*+M_0)+\frac{(1-\mu)\lambda+\mu p_+}{\mu(1-p_+)}(\rho-\rho_0)+M_+-(\rho-\rho_0).$$

In other words, in the first case we deal with a parameter constellation such that if there is a flight-to-safety, all firms can be saved —- there is enough liquidity to cover all demand. In the latter case, some first still have to be liquidated in case of a systemic event, even with flight-to-safety.

By offering the contract $\{L_D^{**},y^*\}$ with implicit guarantee, the banks earn per-period profit:

$$\pi_D(L_D^{**},y^*)=-qL_D^{**}-E(M)+(1-\mu)\left[L_D^{**}+E(M)-(1-\lambda)y^*-\lambda(\rho-\rho_0)\right]+\mu p_+\max(M_++L_D^{**}-(\rho-\rho_0),0),$$

where $E(M)=p_+M_++(1-p_+)M_0$. Providing liquidity insurance in case of non-systemic events costs the bank less than it benefits firms, and the created surplus accrues to banks. Providing extra liquidity coverage to firms in case of flight-to-safety does not require the bank to purchase bonds and lose on liquidity premium. It also creates a surplus that accrues to banks — L_D^{**} is smaller than L that banks would have had to offer firms if the implicit guarantee covered only non-systemic events and did not extend to the flight-to-safety extra deposits M_+-M_0. The banks with reputation that offer contracts $\{L_D^{**},y^*\}$ capture all the business when their discount rate is not too high and therefore the deviations are not optimal:

$$\frac{\pi_D(L_D^{**},y^*)}{\bar{r}_D}>\begin{cases}\max\left[\lambda\left(1-\frac{L_D^{**}+M_0}{\rho-\rho_0}\right)(\rho-\rho_0);M_+-M_0\right] & \text{if } A<0,\\ \max\left[\lambda\left(1-\frac{L_D^{**}+M_0}{\rho-\rho_0}\right)(\rho-\rho_0);1-L_D^{**}-M_0\right] & \text{if } A\geq 0,\end{cases}$$

where A is defined above. This defines $\bar{r}_D$.

$\square$

Extension: Renegotiations

In this extension we consider the effect of renegotiations on the revocation pattern. By renegotiations we mean the willingness of banks to preserve business with the firm following a covenant violation because of future cash flows. In other words, situations when the firm's liquidity shock is below its pledgeable income.

To make renegotiations between banks and firms feasible, we extend the model by allowing $\rho \sim [0, \rho_1]$ with distribution function $\Phi(\rho)$. Since $\rho_0 < \rho_1$, for realizations of liquidity shock below ρ_0, the entrepreneur can raise necessary funds using external capital markets. Only when the liquidity shock is above the pledgeable income, the entrepreneur cannot continue without insurance coverage of the bank's credit line.

Let's first consider the credit line contract that a bank without reputation can offer to a firm. Without loss of generality, we assume the following fee structure — if the firm is not affected by a liquidity shock, it pays y. If the firm is affected by $\rho < \rho_0$, it pays $\rho_0 - \rho$. The contract has a threshold for covenant violation $\bar{\varepsilon}$. Firms with $\varepsilon > \bar{\varepsilon}$ are considered to not violate a covenant, and in case of $\rho > \rho_0$ are provided with liquidity insurance of $\rho - \rho_0$.

Payoff of the entrepreneur with a credit line contract:

$$
\begin{array}{lll}
H(\bar{\varepsilon}, y) & = & \\
1-\mu & \text{normal times} & -(1-\lambda)y + (1-\lambda)\rho_1 + \lambda\left[\int_0^{\rho_0}(\rho_1-\rho_0)\phi(\rho)d\rho + (1-F(\bar{\varepsilon}))\int_{\rho_0}^{\rho_1}(\rho_1-\rho_0)\phi(\rho)d\rho\right] \\
\mu & \text{systemic event} & \int_0^{\rho_0}(\rho_1-\rho_0)\phi(\rho)d\rho + (1-F(\bar{\varepsilon}))\int_{\rho_0}^{\rho_1}(\rho_1-\rho_0)\phi(\rho)d\rho
\end{array}
$$

Entrepreneur's payoff without a credit line contract:

$$
\begin{array}{lll}
H_0 & = & \\
1-\mu & \text{normal times} & (1-\lambda)\rho_1 + \lambda\left[\int_0^{\rho_0}(\rho_1-\rho_0)\phi(\rho)d\rho + \int_0^{\rho_0}(\rho_0-\rho)\phi(\rho)d\rho\right] \\
\mu & \text{systemic event} & \int_0^{\rho_0}(\rho_1-\rho_0)\phi(\rho)d\rho + \int_0^{\rho_0}(\rho_0-\rho)\phi(\rho)d\rho
\end{array}
$$

Therefore, the benefit of having a credit line contract for the entrepreneur is:

$$
\begin{array}{lll}
\widetilde{H(\bar{\varepsilon},y)} & = & \\
1-\mu & \text{normal times} & -(1-\lambda)y+\lambda(1-F(\bar{\varepsilon}))\int_{\rho_0}^{\rho_1}(\rho_1-\rho_0)\phi(\rho)d\rho-\lambda\int_0^{\rho_0}(\rho_0-\rho)\phi(\rho)d\rho \\
\mu & \text{systemic event} & (1-F(\bar{\varepsilon}))\int_{\rho_0}^{\rho_1}(\rho_1-\rho_0)\phi(\rho)d\rho-\int_0^{\rho_0}(\rho_0-\rho)\phi(\rho)d\rho
\end{array}
$$

Let us introduce the following notation to simplify the exposition:

$$
\begin{aligned}
P &= \int_{\rho_0}^{\rho_1}(\rho_1-\rho_0)\phi(\rho)d\rho \\
S &= \int_0^{\rho_0}(\rho_0-\rho)\phi(\rho)d\rho \\
D &= \int_{\rho_0}^{\rho_1}(\rho-\rho_0)\phi(\rho)d\rho
\end{aligned}
$$

Then the entrepreneur's profit is:

$$
\begin{aligned}
\widetilde{H(\bar{\varepsilon},y)} &= -(1-\mu)(1-\lambda)y+\lambda(1-\mu)\left[(1-F(\bar{\varepsilon}))P-S\right]+\mu\left[(1-F(\bar{\varepsilon}))P-S\right] \\
&= -(1-\mu)(1-\lambda)y+(\mu+\lambda(1-\mu))\left[(1-F(\bar{\varepsilon}))P-S\right]
\end{aligned}
$$

The bank's profit from offering the credit line contract described above is:

$$
\begin{array}{lll}
\pi((\bar{\varepsilon},y)) & = & -qL \\
1-\mu & \text{normal times} & L+(1-\lambda)y+\lambda S-\lambda(1-F(\bar{\varepsilon}))D \\
\mu & \text{systemic event} & L+S-(1-F(\bar{\varepsilon}))D=0 \\
\pi((\bar{\varepsilon},y)) & = & -qL+(1-\mu)\left[L+(1-\lambda)y+\lambda S-\lambda(1-F(\bar{\varepsilon}))D\right] \\
1-F(\bar{\varepsilon}) & = & \dfrac{L+S}{D} \\
\pi((\bar{\varepsilon},y)) & = & [-q+(1-\mu)(1-\lambda)]L+(1-\mu)(1-\lambda)y
\end{array}
$$

$$\widetilde{H(\tilde{\varepsilon},y)} = -(1-\mu)(1-\lambda)y+(\mu+\lambda(1-\mu))\left[\frac{L+S}{D}P-S\right]$$

Consider the set of parameters under which the bank without reputation can offer a profitable credit line contract to entrepreneurs, and covenants are an essential part of the contract.

$$\begin{aligned}
\frac{\partial L}{\partial y}_H &= -\frac{\partial H/\partial y}{\partial H/\partial L} = \frac{(1-\mu)(1-\lambda)}{\mu+\lambda(1-\mu)}\frac{D}{P} = \frac{(1-\mu)(1-\lambda)}{1-(1-\mu)(1-\lambda)}\frac{D}{P} \\
\frac{\partial L}{\partial y}_\pi &= -\frac{\partial \pi/\partial y}{\partial \pi/\partial L} = -\frac{(1-\mu)(1-\lambda)}{-q+(1-\mu)(1-\lambda)} = \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}
\end{aligned}$$

There are feasible credit-line contracts that banks can offer to entrepreneurs if:

$$\begin{aligned}
\frac{\partial L}{\partial y}_\pi &> \frac{\partial L}{\partial y}_H \\
\frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)} &> \frac{(1-\mu)(1-\lambda)}{1-(1-\mu)(1-\lambda)}\frac{D}{P} \\
\frac{1-(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)} &> \frac{D}{P}
\end{aligned}$$

And for covenants to play a role in the credit-line contract, $(L^*+S)/D < 1$, or $L^* < D-S$. Since the problem is still linear in L and y, the equilibrium with banks without reputation that compete for entrepreneurs would be $y_0 = \rho_0$ and with L^* that comes from $\pi(L^*,\rho_0) = 0$.

$$\begin{aligned}
\pi(L^*,\rho_0) = 0 &= (1-\mu)(1-\lambda)\rho_0 - [q-(1-\mu)(1-\lambda)]L^* \\
L^* &= \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0
\end{aligned}$$

The condition then for the role of covenants is:

$$\begin{aligned} L^* &< D-S \\ \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0 &< D-S \end{aligned}$$

Credit line contracts with reputation can overcome the inefficiency that entrepreneurs are willing to pay for coverage in normal times $P = \int_{\rho_0}^{\rho_1}(\rho_1-\rho_0)\phi(\rho)d\rho$, while the cost of providing this insurance is $D = \int_{\rho_0}^{\rho_1}(\rho-\rho_0)\phi(\rho)d\rho$, and clearly $P > D$, while the banks without reputation cannot offer protection to firms that violated covenants in normal times.

$$\begin{aligned} \widetilde{H'(\bar{\varepsilon},y)} &= \\ 1-\mu \quad \text{normal times} &\quad -(1-\lambda)y+\lambda P-\lambda S \\ \mu \quad \text{systemic event} &\quad (1-F(\bar{\varepsilon}))P-S \\ \widetilde{H'(\bar{\varepsilon},y)} &= -(1-\mu)(1-\lambda)y+(1-\mu)\lambda(P-S)+\mu\left(\frac{L+S}{D}P-S\right) \end{aligned}$$

$$\begin{aligned} \pi'((\bar{\varepsilon},y)) &= -qL \\ 1-\mu \quad \text{normal times} &\quad L+(1-\lambda)y+\lambda S-\lambda D \\ \mu \quad \text{systemic event} &\quad L+S-(1-F(\bar{\varepsilon}))D=0 \\ \pi'((\bar{\varepsilon},y)) &= -qL+(1-\mu)\left[L+(1-\lambda)y+\lambda S-\lambda D\right] \\ 1-F(\bar{\varepsilon}) &= \frac{L+S}{D} \end{aligned}$$

There are feasible contracts when

$$\begin{aligned}
\frac{\partial L}{\partial y}_{\pi'} &> \frac{\partial L'}{\partial y}_{H} \\
\frac{(1-\mu)(1-\lambda)}{q-(1-\mu)} &> \frac{(1-\mu)(1-\lambda)}{\mu}\frac{D}{P} \\
\frac{\mu}{q-(1-\mu)} &> \frac{D}{P}
\end{aligned}$$

Assumption 1 will be required to restrict parameters such that the inequality above is satisfied.

Since liquidity in systemic events is more costly than in normal times, the banks with reputation will re-allocate the insurance coverage to normal times, therefore, $L^{**} < L^{*}$.

Therefore, the two assumptions can be written as:

$$\begin{aligned}
&\text{Assumption 1:} \quad \frac{\mu}{q-(1-\mu)} > \frac{D}{P} \\
&\text{Assumption 2:} \quad \frac{(1-\mu)(1-\lambda)}{q-(1-\mu)(1-\lambda)}\rho_0 < D-S
\end{aligned}$$

L^{**} can be found from setting equal survival probabilities of the entrepreneur in case of a credit line contract with and without an implicit guarantee.

If both Assumption 1 and Assumption 2 are satisfied, moreover, if the discount rate of the banks with reputation is not too high, then the following equilibrium will be supported: banks with reputation offer credit-line contracts L^{**}, ρ_0 to entrepreneurs, while banks without reputation are out of business. In case of a covenant violation in normal times, banks preserve firms' access to liquidity, while in a systemic event firms that violate a covenant lose the credit-line.

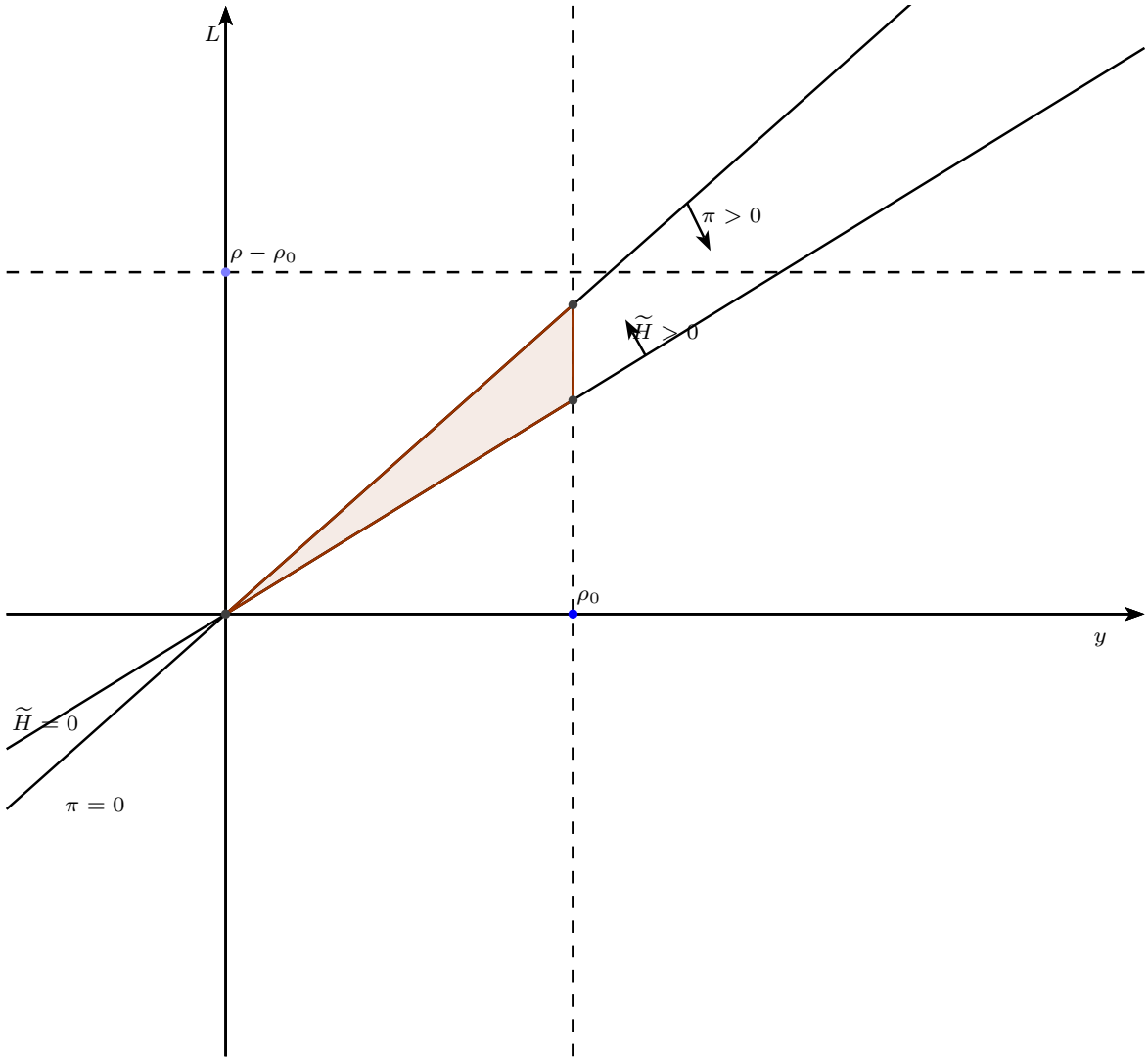


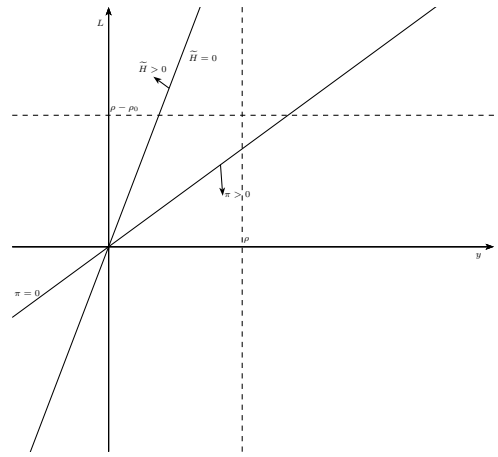
Figure 1: Admissible and feasible contracts $\{L, y\}$ if the bank always revokes credit lines whenever the covenants are violated.

Cases | Graph

1) Prohibively high liquidity premium

$$\frac{q-(1-\mu)(1-\lambda)}{1-(1-\mu)(1-\lambda)} > \frac{p_h B/\Delta p}{\rho-\rho_0}$$

$$\{L^*, y^*\} = \{0, 0\}$$

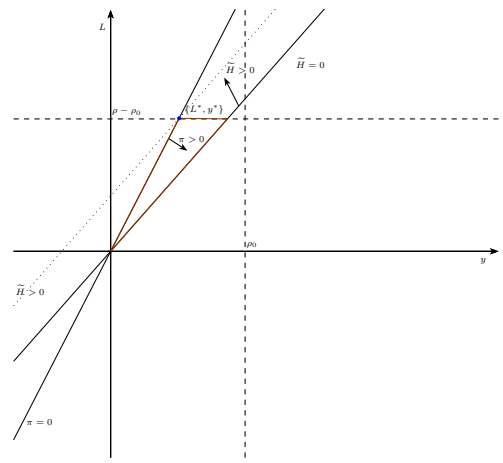


2) Full Liquidity Coverage

$$\frac{q-(1-\mu)(1-\lambda)}{1-(1-\mu)(1-\lambda)} < \frac{p_h B/\Delta p}{\rho-\rho_0}$$

$$\frac{q-(1-\mu)(1-\lambda)}{(1-\mu)(1-\lambda)} < \frac{\rho_0}{\rho-\rho_0}$$

$$\{L^*, y^*\} = \{\rho - \rho_0, < \rho_0\}$$



3) Partial liquidations and Covenants

$$\frac{q-(1-\mu)(1-\lambda)}{1-(1-\mu)(1-\lambda)} < \frac{p_h B/\Delta p}{\rho-\rho_0}$$

$$\frac{q-(1-\mu)(1-\lambda)}{(1-\mu)(1-\lambda)} > \frac{\rho_0}{\rho-\rho_0}$$

$$\{L^*, y^*\} = \{< \rho - \rho_0, \rho_0\}$$

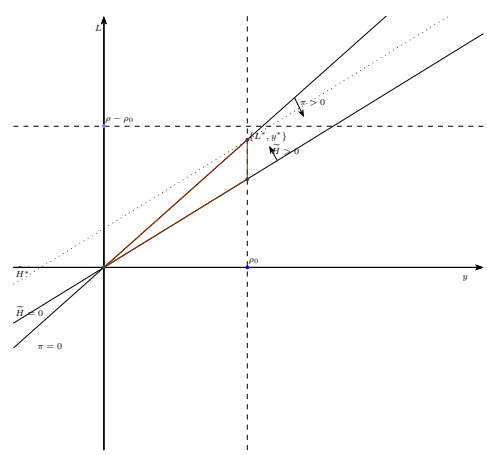


Figure 2: Equilibrium contracts $\{L, y\}$ when bank revokes the credit line whenever covenants are violated. The firms are assumed to have all the bargaining power, the bank breaks even on each contract. Three cases of parameter constellations are possible. In the first case, the liquidity premium is prohibitively high relative to the moral-hazard problem, so the demand for liquidity insurance is zero. In the second case, the liquidity premium relative to the moral-hazard problem is so low that it is possible to buy full protection against the liquidity shock. In the third case, firms demand partial protection and the scarce liquidity is allocated using covenants. Firms that violate the covenants are liquidated.

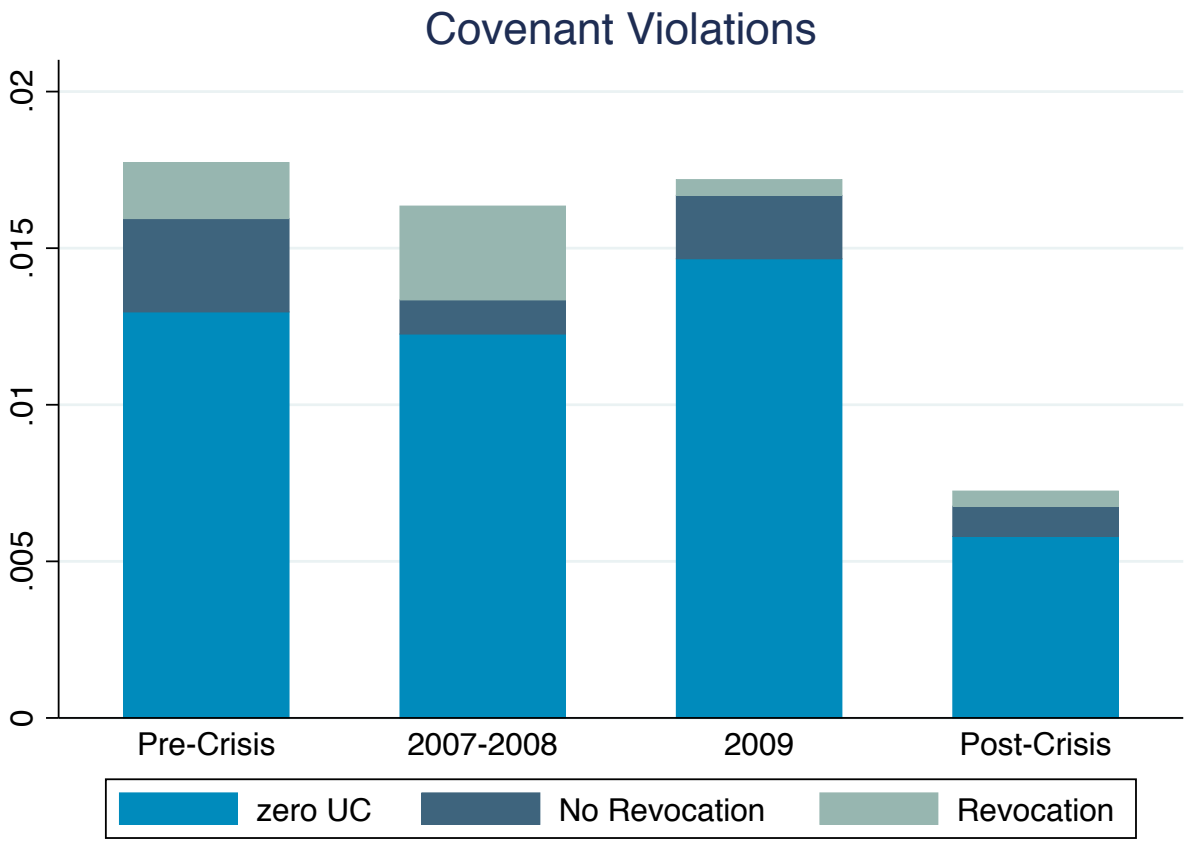


Figure 3: **Covenant Violations in Time**
The bars' height represents the frequency of covenant violations in a given time period. Our sample starts in 2002 and ends in 2012. Filters that were applied to data are described in the data section. "zero UC" describes violations that occured in firms that did not have any undrawn credit in the previous year. "Revocation" stands for cases when the undrawn credit falls to zero in the year of covenant violation and the change in drawn amount is not sufficient to explain the change in the undrawn amount. "No Revocation" is the complement to "Revocation" and captures instances when firms in covenant violations had undrawn credit in the previous year and preserved acces to credit in the year of the covenant violation.

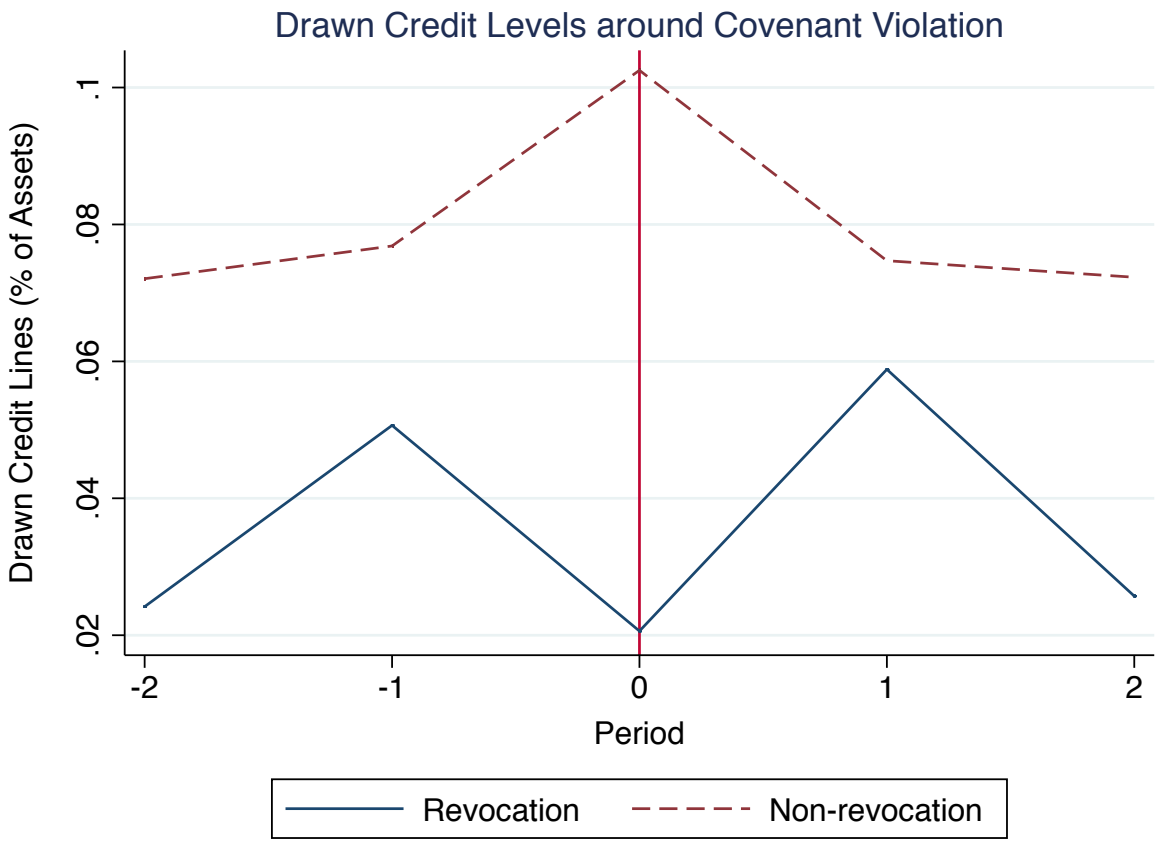


Figure 4: **Drawn Credit Lines around Covenant Violation**
This graph shows the effect of a covenant violation on drawn credit lines scaled by previous period total assets for both companies that experience a revocation upon covenant violation and those that do not experience a revocation upon covenant violation. The sample includes borrowers that violate a covenant only once (at time $t = 0$) during the five year window.

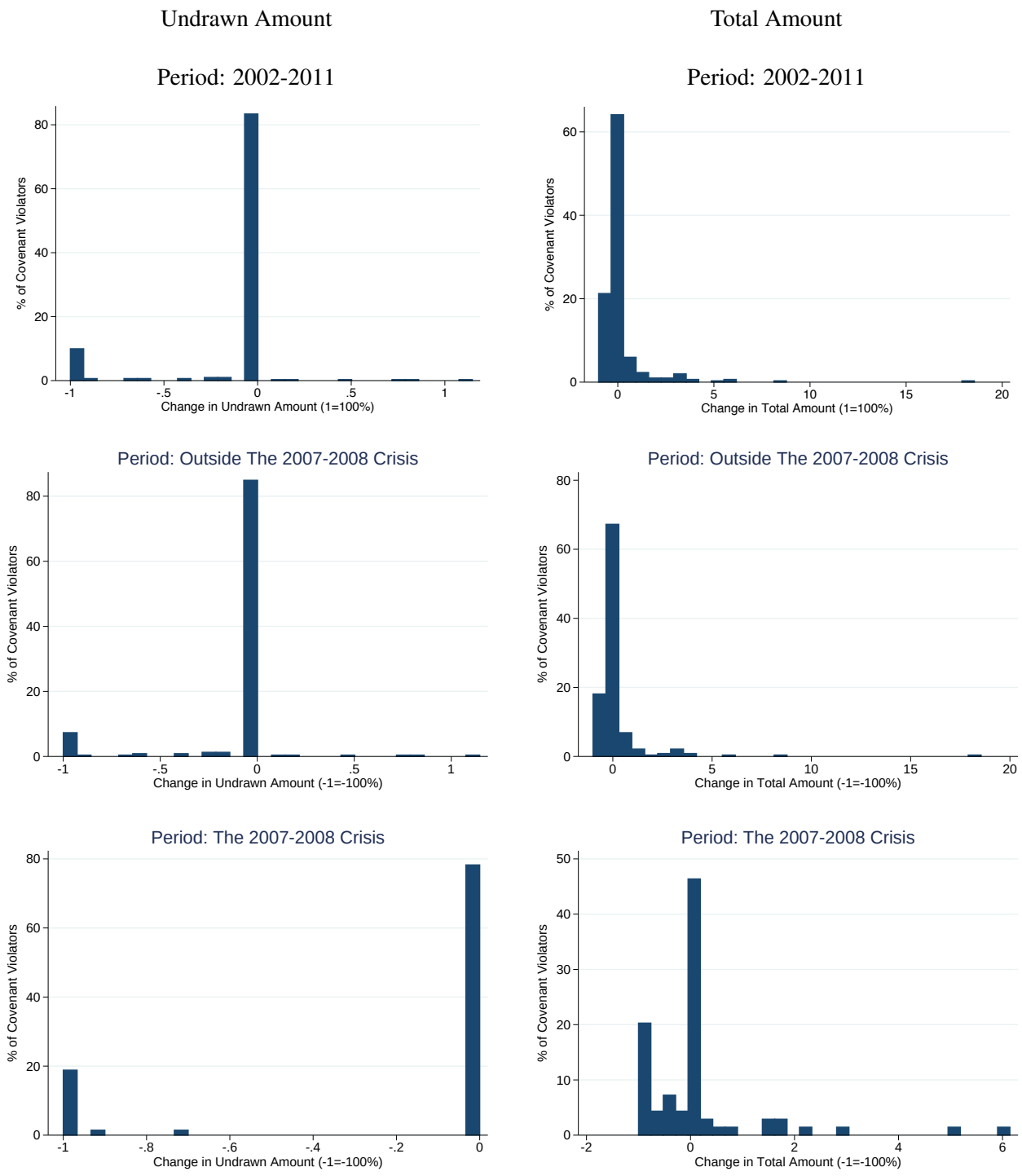


Figure 5: Changes in the Undrawn and Total amount of Credit Line following a covenant violation.

Table 1: **Definition of Variables**
Variable definitions are below. Compustat variable names are denoted by their Xpressfeed pneumonic in bold. SNL Financial identifiers are reported in bold.

Firm variables:	**Description**
Covenant Violation	A dummy variable equal one if a new violation, and zero otherwise
Leverage	Total Debt/Total Assets (**(dlc+dltt)/at**)
Capex	Capital Expenditures/Total Assets (**capx/at**)
Cash	Cash and Short-Term Investments/Total Assets (**che/at**)
Dividend Payer Dummy	A dummy variable equal one if dividends (**dvc**) are positive, zero otherwise
Market-to-Book	Market Value of Assets / Total Assets (**(at+(prcc_f*csho)-ceq-txdb)/at**)
NWC	Working Capital-Cash and Short-Term Investments/Total Assets (**(wcap-che)/at**)
Profitability	Operating Income Before Depreciation /Total Assets (**oibdp/at**)
CF Volatility	Standard Deviation of Profit over Previous 5 Years
R&D/Sales	Research and Development Expenses/Sales (**xrd/sale**)
Size	Logarithm of Revenues (ln(**sale**))
Debt in 1-5 Years	Total debt maturing in one, or two..., or five years (**dd**n**/at**, where n=1...5)
Tangibility	Net Property Plant and Equipment/Total Assets (**ppent/at**)
Age	The natural log of the number of years the bank has been public
Bank variables:	**Description**
Lender Capital Ratio	Book value of capital divided by total assets (SNL:**133176**)
Lender Liquidity Ratio	Liquid assets and securities divided by total assets (SNL:**142215**)
Lender Deposit Ratio	Total deposits (SNL:**132288**) divided by total assets(SNL:**132264**)
Lender NPLs	Loans past due 90 days or more and non-accruals divided by total loans (SNL:**142099**)
Lender Reputation	A dummy variable equal one if the bank lends more than once, zero otherwise
Lender Age	The natural log of the number of years the bank has been public
Lender Size	Logarithm of revenues

Table 2: **Summary Statistics**
This table presents descriptive statistics for the main variables used in the analysis for the entire sample period from 2002 to 2011. The units are firm-years. Bank-level variables are in percent. To control for the effect of outliers in the subsequent estimations we trim variables with outliers at 1% in both tails of the distribution. All variables are defined in table 1.

Variable	Obs	Mean	Std. Dev.	Min	Max
Covenant Violation	19827	0.02	0.12	0.0	1.0
Profitability	19667	0.10	0.16	-1.2	0.46
Size	19142	6.42	2.08	0.1	10.76
Leverage	19827	0.23	0.18	0.0	0.91
Market-to-Book	19623	1.80	1.26	0.5	7.37
Cash	19614	0.16	0.18	0.0	0.95
Tangibility	19794	0.29	0.24	0.0	0.99
NWC	19028	0.06	0.16	-0.8	0.52
Capex	19657	0.05	0.06	0.0	0.37
R&D	19827	0.14	1.05	0.0	7.39
Dividend dummy	19827	0.41	0.49	0.0	1.0
Age	19826	2.54	0.85	1.23	3.88
CF Vol	18924	0.07	0.35	0.0	2.78
Debt 1Year	19325	0.02	0.03	0.0	0.26
Debt 2Year	16877	0.02	0.04	0.0	0.29
Debt 3Year	16742	0.02	0.05	0.0	0.31
Debt 4Year	16842	0.02	0.05	0.0	0.32
Debt 5Year	16546	0.02	0.05	0.0	0.34
Lender Capital Ratio	156	13.15	1.94	10.0	21.0
Lender Liquidity Ratio	155	29.47	16.82	4.0	64.0
Lender Deposit Ratio	161	59.0	15.0	0.0	88.0
Lender NPLs	154	1.76	1.82	0.0	7.0
Lender Reputation	174	0.84	0.37	0.0	1.0
Lender Age	169	3.78	0.63	1.1	5.26
Lender Size	166	19.4	2.09	12.31	21.54

Table 3: Revocations and Covenant Violations

Year	**2002**	**2003**	**2004**	**2005**	**2006**	**2007**	**2008**	**2009**	**2010**	**2011**
Observations	1747	1770	1805	1819	1891	2019	2110	2186	2240	2240
Total Revocations	n.a.	114	155	106	152	151	120	80	75	21
Total Covenant Violations (CV)	42	37	26	34	27	30	39	35	20	11
Rev. due to Violation	n.a.	3	5	3	2	5	7	1	2	0
Rev. due to Violation (% CV)	n.a.	8%	19%	9%	7%	17%	18%	3%	10%	0%
Rev. due to Non-Violation	n.a.	111	150	103	150	146	113	79	73	0
Rev. due to Non-Violation (% NV)	n.a.	6%	8%	6%	8%	7%	6%	4%	3%	0%

Table 4: **Summary of Covenant Restrictions**
The table presents a list of covenant restrictions found in loans to non-financial firms in the intersection of the merged Capital IQ-Compustat database and Dealscan during the period 2002 to 2011. Although we do not use the Dealscan dataset for our analysis, this table provides information on the frequency of covenant types found in our dataset. *Number of firms* represents the number of companies having the corresponding covenant restriction. *Number of unique firms* corresponds to the total number of firms in our Capital IQ-Compustat merged sample.

Covenant Type	Number of firms	Number of unique firms	%
Min. (Tangible) Net Worth	395	3830	10
Max. Capex	619	3830	16
Max. Debt to EBITDA	947	3830	25
Max. Senior Debt to EBITDA	45	3830	1
Max. Debt to Equity	12	3830	0
Max. Debt to Tangible Net Worth	108	3830	3
Max. Leverage Ratio	199	3830	5
Min. Current Ratio	37	3830	1
Min. Debt Service Coverage	26	3830	1
Min. EBITDA	47	3830	1
Min. Fixed Charge Coverage	137	3830	4
Min. Interest Coverage	60	3830	2
Min. Quick Ratio	19	3830	0

Table 5: **The Time Effects of Covenant Violations on Credit Line Revocations**
This table presents probit (marginal effects dF/dx) regression results for the contemporaneous and lagged (up to five periods) relation between new covenant violations and credit line revocations. The estimation procedure is described in section 7.4. The dependent variable is a dummy equal to one if there is a revocation and zero otherwise. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

VARIABLES	(1) Revocation
Covenant Violation$_t$	0.0479***
	(0.016)
Covenant Violation$_{t-1}$	0.0061
	(0.020)
Covenant Violation$_{t-2}$	0.0165
	(0.017)
Covenant Violation$_{t-3}$	-0.0148
	(0.022)
Covenant Violation$_{t-4}$	-0.0164
	(0.021)
Covenant Violation$_{t-5}$	-0.0172
	(0.021)
Observations	7,005

Table 6: **The Effect of Covenant Violations on Credit Line Revocations** This table presents probit (marginal effects dF/dx) regression results for the contemporaneous relation between new covenant violations (both with and without the presence of a crisis period) and credit line revocations. The estimation procedure is described in section 7.5. The dependent variable is a dummy equal to one if there is a revocation and zero otherwise. Industry, rating and exchange fixed effects are included in column four and only industry and rating fixed effects in columns five and six. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. All regressions include a constant term (unreported).

VARIABLES	(1) No Controls	(2) Full	(3) Full	(4) Full	(5) Full	(6) Full	(7) Full
Covenant Violation x $\text{Crisis}_{2007-2008}$	0.03360	0.07045**	0.07198**	0.07084**	0.06922**	0.07060**	0.08207**
	(0.027)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.035)
Covenant Violation x Crisis_{2009}	-0.05069	0.01852	0.02144	0.01977	0.01700	0.02020	0.04154
	(0.053)	(0.060)	(0.060)	(0.060)	(0.059)	(0.060)	(0.061)
$\text{Crisis}_{2007-2008}$	0.0120***	0.0130***	0.0138***	0.0151***	0.0145***	0.0151***	-0.01376
	(0.004)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.029)
Crisis_{2009}	-0.0197***	-0.0247***	-0.0238***	-0.0223***	-0.0229***	-0.0225***	-0.09347*
	(0.006)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.050)
Covenant Violation_t	0.0350**	-0.00936	-0.00856	-0.00776	-0.00870	-0.00829	-0.01125
	(0.016)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
$\text{Profitability}_{t-1}$		-0.01009	-0.01031	0.00292	0.00238	0.00181	-0.02530
		(0.025)	(0.026)	(0.026)	(0.025)	(0.026)	(0.032)
Size_{t-1}		-0.00204	-0.00242*	-0.00626***	-0.00542***	-0.00558***	-0.00645***
		(0.001)	(0.001)	(0.002)	(0.002)	(0.002)	(0.002)
Leverage_{t-1}		-0.00529	0.00331	-0.00926	-0.01008	-0.00855	0.01480
		(0.028)	(0.018)	(0.020)	(0.028)	(0.020)	(0.023)
$\text{Market-to-Book}_{t-1}$		0.00165	0.00200	0.00157	0.00130	0.00166	0.00173
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Cash_{t-1}		-0.08053***	-0.08422***	-0.07822***	-0.07649***	-0.07946***	-0.10329***
		(0.020)	(0.021)	(0.020)	(0.020)	(0.020)	(0.024)
Tangibility_{t-1}		-0.04095***	-0.03730***	-0.03532**	-0.04050***	-0.03450**	-0.03312*
		(0.014)	(0.014)	(0.016)	(0.015)	(0.016)	(0.018)
$\text{NetWorkingCapital}_{t-1}$		0.03769**	0.03605**	0.02607	0.02730	0.02603	0.03010

		(0.016)	(0.017)	(0.020)	(0.019)	(0.020)	(0.023)
Capex$_{t-1}$		0.10856**	0.09027*	0.10514*	0.12403**	0.10209*	0.12804*
		(0.052)	(0.053)	(0.056)	(0.054)	(0.056)	(0.069)
R&D$_{t-1}$		-0.04748**	-0.04849**	-0.05249**	-0.04924**	-0.05366**	-0.05529**
		(0.023)	(0.022)	(0.023)	(0.024)	(0.024)	(0.028)
Dividend dummy$_{t-1}$		0.01796***	0.01821***	0.01526***	0.01552***	0.01613***	0.00964
		(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.006)
CF Vol$_{t-1}$		-0.03132	-0.03089	-0.02738	-0.02784	-0.02779	-0.04154
		(0.031)	(0.031)	(0.027)	(0.027)	(0.028)	(0.046)
Firm Age$_{t-1}$		-0.04168***	-0.04299***	-0.04277***	-0.04176***	-0.04332***	-0.04469***
		(0.006)	(0.006)	(0.007)	(0.006)	(0.007)	(0.007)
Industry Fixed Effects	no	no	no	yes	yes	yes	yes
Rating Fixed Effects	no	no	no	yes	yes	yes	yes
Stock Exchange Fixed Effects	no	no	no	yes	no	no	no
Debt Maturity Controls	no	$>$ 3 years	all years	all years	$>$ 3 years	all years	all years
Controls x Crisis (07-08/09) interactions	no	no	no	no	no	no	yes
Pseudo R^2	0.01	0.03	0.03	0.04	0.03	0.04	0.04
Observations	16,953	11,946	11,382	11,343	11,902	11,343	11,268

Table 7: **The Effect of Covenant Violations on Credit Line Revocations: Violators Sub-sample Analysis** This table presents probit (marginal effects dF/dx) regression results in columns one to four and pooled regression results in columns five and six. The sample is restricted to firms that violate a covenant. The estimation procedure is described in section 7.5. The dependent variable is a dummy equal to one if there is a revocation and zero otherwise in the probit estimation. The dependent variable is the ratio of unused credit lines to lagged assets in columns five and six. Industry, rating and exchange fixed effects are included in columns four and six. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. All regressions include a constant term (unreported).

VARIABLES	(1) No Controls	(2) Full	(3) Full	(4) Full	(5) Full	(6) Full
$\text{Crisis}_{2007-2008}$	0.07357*	0.07174*	0.08268**	0.16920**	-0.02447***	-0.02791***
	(0.043)	(0.041)	(0.041)	(0.074)	(0.009)	(0.011)
Crisis_{2009}	-0.10178	-0.05133	-0.02776	0.06585	0.02155	0.01773
	(0.083)	(0.075)	(0.073)	(0.173)	(0.039)	(0.041)
$\text{Profitability}_{t-1}$		-0.44775	-0.47722*	-1.10019*	0.04236	0.08090
		(0.273)	(0.248)	(0.570)	(0.043)	(0.063)
Size_{t-1}		0.01260	0.00726	0.02871	-0.00159	0.00267
		(0.012)	(0.012)	(0.034)	(0.004)	(0.004)
Leverage_{t-1}		-0.16923*	-0.21722	-1.44909**	-0.03648	0.05260
		(0.103)	(0.215)	(0.576)	(0.040)	(0.061)
$\text{Market-to-Book}_{t-1}$		0.03849	0.03736	0.17997*	0.00373	-0.00061
		(0.024)	(0.026)	(0.105)	(0.006)	(0.008)
Cash_{t-1}		-0.05758	0.01019	0.53158	-0.05328*	-0.07768
		(0.199)	(0.194)	(0.325)	(0.032)	(0.052)
Tangibility_{t-1}		-0.09319	0.00137	0.42375	-0.02063	0.00180
		(0.105)	(0.095)	(0.351)	(0.035)	(0.036)
$\text{NetWorkingCapital}_{t-1}$		-0.23289*	-0.20894*	-1.12098***	-0.02072	-0.05273
		(0.119)	(0.123)	(0.423)	(0.024)	(0.063)
Capex_{t-1}		0.12792	0.07395	-1.86508	-0.04651	0.05082
		(0.308)	(0.302)	(1.332)	(0.081)	(0.114)
$\text{R\&D}_{t-1}$		-0.65777**	-0.45464*	-0.49383	-0.00252	0.00864
		(0.283)	(0.264)	(0.515)	(0.009)	(0.021)
$\text{Dividend dummy}_{t-1}$		0.04273	0.04876	0.00572	-0.01834	-0.01560
		(0.054)	(0.054)	(0.118)	(0.013)	(0.015)
CF Vol_{t-1}		-0.48265*	-0.51077	-2.17051**	0.08777	0.06770
		(0.254)	(0.318)	(0.965)	(0.074)	(0.060)
Firm Age_{t-1}		-0.06200	0.01090	0.02451	0.04626**	0.04514*
		(0.067)	(0.065)	(0.129)	(0.020)	(0.024)
Industry Fixed Effects	no	no	no	yes	no	yes
Rating Fixed Effects	no	no	no	yes	no	yes
Stock Exchange Fixed Effects	no	no	no	yes	no	yes
Debt Maturity Controls	no	no	$>$ 3 years	all years	$>$ 3 years	all years
Pseudo R^2 / Adj. R^2	0.04	0.13	0.20	0.39	0.08	0.24
Observations	243	210	184	94	188	184

Table 8: **The Effect of Covenant Violations on Credit Line Revocations: Constant sample size** This table presents probit (marginal effects dF/dx) regression results for the contemporaneous relation between new covenant violations (both with and without the presence of a crisis period) and credit line revocations. The estimation procedure is described in section 7.5. We perform all estimations with the same sample size. The dependent variable is a dummy equal to one if there is a revocation and zero otherwise. Industry, rating and exchange fixed effects are included in column four and only industry and rating fixed effects in columns five and six. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. All regressions include a constant term (unreported).

The Effect of Covenant Violations on Credit Line Revocations

VARIABLES	(1) No Controls	(2) Full	(3) Full	(4) Full	(5) Full	(6) Full
Covenant Violation x $\text{Crisis}_{2007-2008}$	0.07044**	0.07220**	0.07214**	0.07084**	0.07068**	0.07060**
	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)	(0.034)
Covenant Violation x Crisis_{2009}	0.01787	0.02157	0.02144	0.01977	0.02019	0.02020
	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)	(0.060)
$\text{Crisis}_{2007-2008}$	0.01268**	0.01383***	0.01385***	0.01517***	0.01515***	0.01511***
	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
Crisis_{2009}	-0.02964***	-0.02373***	-0.02382***	-0.02238***	-0.02232***	-0.02251***
	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)	(0.008)
Covenant Violation_t	-0.00492	-0.00878	-0.00861	-0.00776	-0.00849	-0.00829
	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)	(0.023)
$\text{Profitability}_{t-1}$		-0.01110	-0.00970	0.00292	0.00062	0.00181
		(0.026)	(0.026)	(0.026)	(0.026)	(0.026)
Size_{t-1}		-0.00232*	-0.00242*	-0.00626***	-0.00553***	-0.00558***
		(0.001)	(0.001)	(0.002)	(0.002)	(0.002)
Leverage_{t-1}		-0.00760	0.00340	-0.00926	-0.01302	-0.00855
		(0.029)	(0.018)	(0.020)	(0.029)	(0.020)
Market-to-Book_{t-1}		0.00209	0.00206	0.00157	0.00168	0.00166
		(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
Cash_{t-1}		-0.08283***	-0.08358***	-0.07822***	-0.07889***	-0.07946***
		(0.021)	(0.021)	(0.020)	(0.020)	(0.020)
Tangibility_{t-1}		-0.03815***	-0.03819***	-0.03532**	-0.03452**	-0.03450**
		(0.014)	(0.014)	(0.016)	(0.016)	(0.016)

NetWorkingCapital$_{t-1}$		0.03556**	0.03516**	0.02607	0.02664	0.02603
		(0.017)	(0.017)	(0.020)	(0.020)	(0.020)
Capex$_{t-1}$		0.08848*	0.08901*	0.10514*	0.10165*	0.10209*
		(0.053)	(0.053)	(0.056)	(0.056)	(0.056)
R&D$_{t-1}$		-0.04973**	-0.04965**	-0.05249**	-0.05366**	-0.05366**
		(0.022)	(0.022)	(0.023)	(0.024)	(0.024)
Dividend dummy$_{t-1}$		0.01867***	0.01869***	0.01526***	0.01608***	0.01613***
		(0.005)	(0.005)	(0.005)	(0.005)	(0.005)
CF Vol$_{t-1}$		-0.03102	-0.03092	-0.02738	-0.02791	-0.02779
		(0.031)	(0.031)	(0.027)	(0.028)	(0.028)
Firm Age$_{t-1}$		-0.04351***	-0.04335***	-0.04277***	-0.04342***	-0.04332***
		(0.007)	(0.007)	(0.007)	(0.007)	(0.007)
Industry Fixed Effects	no	no	no	yes	yes	yes
Rating Fixed Effects	no	no	no	yes	yes	yes
Stock Exchange Fixed Effects	no	no	no	yes	no	no
Debt Maturity Controls	no	$>$ 3 years	all years	all years	$>$ 3 years	all years
Pseudo R^2	0.01	0.03	0.03	0.04	0.04	0.04
Observations	11,343	11,343	11,343	11,343	11,343	11,343

Table 9: **The Effect of Covenant Violations on Credit Line Revocations: Time Sub-sample Analysis**
This table presents probit (marginal effects dF/dx) regression results. Each column presents the results for a different time period of our sample. The estimation procedure is described in section 7.5. The dependent variable is a dummy equal to one if there is a revocation and zero otherwise. Industry, rating and exchange fixed effects are included. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. All regressions include a constant term (unreported).

VARIABLES	(1) 2007-2008	(2) 2009	(3) Outside of Crisis
Covenant Violation$_t$	0.07316**	0.02388	-0.01039
	(0.032)	(0.041)	(0.023)
Profitability$_{t-1}$	0.23631***	-0.12173**	-0.03128
	(0.076)	(0.060)	(0.033)
Size$_{t-1}$	-0.00540	0.00504	-0.00804***
	(0.005)	(0.005)	(0.002)
Leverage$_{t-1}$	-0.04538	-0.04094	0.00761
	(0.048)	(0.054)	(0.023)
Market-to-Book$_{t-1}$	-0.01126*	-0.00518	0.00452*
	(0.006)	(0.008)	(0.003)
Cash$_{t-1}$	-0.05565	0.08206	-0.10627***
	(0.051)	(0.051)	(0.024)
Tangibility$_{t-1}$	-0.09298**	-0.02067	-0.02682
	(0.040)	(0.043)	(0.019)
NetWorkingCapital$_{t-1}$	-0.00327	-0.01699	0.03291
	(0.049)	(0.056)	(0.023)
Capex$_{t-1}$	0.16789	0.07177	0.09897
	(0.136)	(0.152)	(0.071)
R&D$_{t-1}$	-0.01039	-0.42884**	-0.05708**
	(0.020)	(0.181)	(0.029)
Dividend dummy$_{t-1}$	0.01711	0.03748**	0.00974
	(0.012)	(0.015)	(0.007)
CF Vol$_{t-1}$	-0.01192	-0.01380	-0.06487
	(0.014)	(0.031)	(0.054)
Firm Age$_{t-1}$	-0.01179	-0.02727	-0.05625***
	(0.018)	(0.019)	(0.008)
Industry Fixed Effects	yes	yes	yes
Rating Fixed Effects	yes	yes	yes
Stock Exchange Fixed Effects	yes	yes	yes
Debt Maturity Controls	all years	all years	all years
Pseudo R^2	0.059	0.118	0.046
Observations	2,513	1,050	7,402

Table 10: **Revocation Decisions Following a Covenant Violation by Bank**
This table presents the bank names that we identified for the sub-sample of covenant violators presented in table 7. We have started with 184 firm-year observations with a covenant violation for which we have COMPUSTAT and Capital IQ data and that were used in our analysis presented in table 7 column 3. Using SEC filings, we hand-collected the identities of the banks that the firms had a credit line with and matched them with SNL Financial data for bank fundamentals. The final sample consists of 174 firm-year observation. Some credit lines were syndicated. In total we have 174 bank-firm-year observation that correspond to 152 unique firms and 53 unique financial institutions.

Bank Name	Non-revoked	Revoked	Total
Bank of America Corporation	36	1	37
Wells Fargo & Company	25	3	28
JPMorgan Chase & Co.	17	4	21
SVB Financial Group	9	1	10
Citigroup Inc.	6		6
MUFG Americas Holdings Corporation	5		5
PNC Financial Services Group, Inc.	4		4
U.S. Bancorp	3	1	4
BB&T Corporation	3		3
KeyCorp	2	1	3
National Bank Holdings Corporation	3		3
PrivateBancorp, Inc.	3		3
Comerica Incorporated	2		2
Deutsche Bank AG	2		2
Lyons Bancorp, Inc.	2		2
Merrill Lynch & Co., Inc.	2		2
SunTrust Banks, Inc.	2		2
Wachovia Corporation	2		2
Zions Bancorporation	2		2
AmSouth Bancorporation		1	1
Bank of Montreal	1		1
Bank of New York Mellon Corporation	1		1
Bank One Corporation	1		1
BOK Financial Corporation	1		1
Bremer Financial Corporation	1		1
Capmark Finacial Group Inc	1		1
Chemical Financial Corporation		1	1
CIT Group Inc.	1		1
Citizens Bank & Trust Company		1	1
Citizens Financial Group, Inc.	1		1
Cole Taylor Financial Group, Inc.	1		1
Commerce Bancshares, Inc.	1		1
Farm Credit System		1	1
First Hawaiian, Inc.	1		1
FleetBoston Financial Corporation	1		1

General Electric Capital Corporation	1		1
HSBC USA Inc.	1		1
Interactive Data Corporation	1		1
LaSalle Bank, F.S.B.	1		1
Laurentian Bank of Canada	1		1
NewAlliance Bancshares, Inc.	1		1
North Fork Bancorporation, Inc.	1		1
People's United Financial, Inc.	1		1
RBC, Inc.	1		1
Regions Financial Corporation	1		1
Royal Bank of Canada	1		1
Santander Holdings USA, Inc.		1	1
State Street Corporation	1		1
TD Bank US Holding Company	1		1
UBS Financial Services Inc.	1		1
Umpqua Holdings Corporation	1		1
Western Financial Corporation	1		1
Total	158	16	174

Table 11: **Bank Reputation and Revocation Probabilities in and out of the crisis**
This table represents the revocation probabilities for firms when firm-year observations are sorted according to the amount of credit-line business that banks are doing with them. We assign a firm-year observation to Group 1 if the firm is borrowing from a bank that appears to provide credit lines more than once in our sample, and to Group 2 otherwise. We use this variable as a proxy for the reputation of a bank attributable to its credit-line business. It is a noisy proxy for how much of the credit-line business the bank is doing. The banks in the Group 1 are likely to care about their reputation as credit-lines providers more than the banks in the Group 2. We observe that the banks in Group 1 had low revocation probabilities outside of the crisis (3.96%), and moreover, increased their revocation probabilities during the crisis by more than 4 times. On the contrary, banks in group 2 had a much higher revocation probability outside of the crisis (12.5%), and increased the revocation probability during the crisis only by a factor of 1.6. These findings are consistent with the model predictions. The wider gap between the revocation probability in and out of the crisis for Group 1 is consistent with the model prediction that banks in Group 1 are offering more discretionary contracts and are therefore waiving more covenant violations outside of the crisis, as compared to the banks in Group 2.

		Crisis		Non-Crisis		Factor
Group 1	Revocations Total	7 39	17.9%	4 101	3.96%	4.5
Group 2	Revocations Total	2 10	20%	3 24	12.5%	1.6

Table 12: **The Effect of Covenant Violations on Credit Line Revocations: Bank Reputation Analysis** This table presents probit (marginal effects dF/dx) regression results for the contemporaneous relation between new covenant violations (both with and without the presence of a crisis period) and credit line revocations. The sample is restricted to firms that violate a covenant as in table 7. We hand-collect information from SEC regulatory filings in the EDGAR data base on the identities of banks that extended credit lines to the firms in our sample. We merge these identities with data obtained from SNL Financial to obtain bank-level variables. The estimation procedure is described in section 9. The dependent variable is a dummy equal to one if there is a revocation and zero otherwise. Rating and exchange fixed effects are included in column four. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively. All regressions include a constant term (unreported).

The Effect of Covenant Violations on Credit Line Revocations

VARIABLES	(1) No Controls	(2) Full	(3) Full	(4) Full
$\text{Crisis}_{2007-2008}$	0.10280**	-0.42573	-0.52969	-0.11472
	(2.239)	(-0.705)	(-0.904)	(-0.215)
Lender Reputation x $\text{Crisis}_{2007-2008}$		0.87062***	0.95744***	0.81523***
		(3.211)	(3.475)	(3.388)
Lender Reputation_t	-0.08630*	-0.13335*	-0.12438*	-0.12983**
	(-1.744)	(-1.877)	(-1.936)	(-2.012)
Lender Capital Ratio x $\text{Crisis}_{2007-2008}$		-0.04342	-0.04134	-0.06470*
		(-1.061)	(-1.049)	(-1.700)
Lender Capital Ratio_t		0.00856	0.00909	0.00936
		(0.414)	(0.453)	(0.535)
Lender Liquidity Ratio x $\text{Crisis}_{2007-2008}$		0.00617*	0.00592*	0.00678**
		(1.734)	(1.736)	(1.982)
Lender Liquidity Ratio_t		0.00120	0.00118	0.00118
		(0.553)	(0.552)	(0.627)
Lender Size_t		-0.03884	-0.04016	-0.03808
		(-1.102)	(-1.157)	(-1.207)
Lender Deposit Ratio_t		0.14509	0.13038	0.10596
		(0.450)	(0.431)	(0.357)
Lender NPLs_t		-0.02782	-0.02926	-0.02321
		(-1.183)	(-1.254)	(-1.009)
Lender Age_t		0.05477	0.05213	0.06167

		(1.037)	(1.005)	(1.490)
Profitability$_{t-1}$		-0.81771**	-0.82720**	-0.65511*
		(-2.143)	(-2.187)	(-1.822)
Size$_{t-1}$		0.01127	0.01317	0.02225
		(0.750)	(0.841)	(1.178)
Leverage$_{t-1}$		-0.26855*	-0.14566	-0.03176
		(-1.768)	(-0.561)	(-0.151)
Market-to-Book$_{t-1}$		0.04157*	0.03855	0.04355
		(1.683)	(1.509)	(1.578)
Cash$_{t-1}$		0.00356	0.02263	0.04926
		(0.014)	(0.085)	(0.236)
Tangibility$_{t-1}$		0.00801	0.00206	0.03342
		(0.066)	(0.018)	(0.289)
NetWorkingCapital$_{t-1}$		-0.22283	-0.20719	-0.26141
		(-1.260)	(-1.166)	(-1.403)
Capex$_{t-1}$		0.27288	0.32505	0.33669
		(0.755)	(0.868)	(0.942)
R&D$_{t-1}$		-1.36281**	-1.40358**	-1.18754**
		(-2.108)	(-2.188)	(-2.023)
Dividend dummy$_{t-1}$		0.12025**	0.11891**	0.12501**
		(2.005)	(2.041)	(2.122)
CF Vol$_{t-1}$		-0.56422	-0.53535	-0.32557
		(-0.953)	(-0.903)	(-0.496)
Firm Age$_{t-1}$		0.14603	0.14885	0.16371
		(0.908)	(0.897)	(1.053)
Industry Fixed Effects	no	no	no	no
Rating Fixed Effects	no	no	no	yes
Stock Exchange Fixed Effects	no	no	no	yes
Debt Maturity Controls	no	$>$ 3 years	all years	all years
Pseudo R^2	0.03	0.12	0.20	0.35
Observations	174	129	129	128

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