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ABSTRACT

We propose and test a theory of corporate liquidity management in which credit lines provided by banks to firms are a form of monitored liquidity insurance. Bank monitoring and resulting credit line revocations help control illiquidity-seeking behavior by firms. Firms with high liquidity risk are likely to use cash rather than credit lines for liquidity management because the cost of monitored liquidity insurance increases with liquidity risk. We exploit a quasi-experiment around the downgrade of General Motors (GM) and Ford in 2005 and find that firms that experienced an exogenous increase in liquidity risk (specifically, firms that relied on bonds for financing in the pre-downgrade period) moved out of credit lines and into cash holdings in the aftermath of the downgrade. We observe a similar effect for firms whose ability to raise equity financing is compromised by pricing pressure caused by mutual fund redemptions. Finally, we find support for the model's other novel empirical implication that firms with low hedging needs (high correlation between cash flows and investment opportunities) are more likely to use credit lines relative to cash, and are also less likely to face covenants and revocations when using credit lines.

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1 Introduction

Theory suggests that the main difference between a credit line and standard debt is that a credit line allows the firm to access pre-committed debt capacity (e.g., Holmstrom and Tirole (1997, 1998) and Shockley and Thakor (1997)). This pre-commitment creates value for credit lines as a corporate liquidity management tool, in that they help insulate the corporation from negative shocks that may hinder access to capital markets. In particular, credit lines can be an effective, and likely cheaper substitute for corporate cash holdings. Nevertheless, the results in Sufi (2009) challenge the notion that credit lines have perfect commitment. Access to credit lines is often restricted precisely when the firm needs it most, that is, following negative profitability shocks that cause contractual covenant violations. In addition, the survey evidence in Lins, Servaes and Tufano (2010) suggests that corporate CFOs do not always use credit lines as precautionary savings against negative profitability shocks, but also to help fund future growth opportunities.

We propose and test a theory of corporate liquidity management that bridges the gap between existing theory and empirical evidence on credit lines. This theory explains how credit line revocation following negative profitability shocks can be optimal, and it shows when the presence of future growth opportunities may induce firms to use credit lines in their liquidity management. The theory generates empirical predictions that we test using a novel dataset on credit lines, and a new identification strategy.

In the model, a fully committed credit line (that is, full and irrevocable liquidity insurance) creates the following problem. While it protects firms from value-destroying profitability shocks, once full insurance is in place firms may gain incentives to engage in risky investments that increase the risk of liquidity shocks ("illiquidity transformation"). Bank-provided credit lines can help eliminate the firm's incentive to engage in illiquidity transformation, because the bank retains the right (through credit line covenants, for example) to revoke access to the credit line if it obtains a signal that the firm may have engaged in illiquidity transformation. Crucially, bank monitoring and line revocation tend to happen in the same states in which the firm needs the credit line the most (liquidity-shock states). This coincidence arises because credit line drawdowns are negative NPV loans for the bank. Thus, the bank's incentive to monitor is strongest precisely when the firm attempts to draw on the credit line. And, in this way, credit line revocation provides incentives *both* for the firm to avoid illiquidity transformation, and for the bank to pay monitoring costs.

In this framework, the cost of credit line-provided liquidity insurance arises not only from direct monitoring costs, but also because credit line revocations cause the firm to pass on valuable investments. In equilibrium, firms may then choose to switch to cash holdings if the cost of credit lines is too high. In particular, the model points to an important determinant of the choice between cash and credit lines - the firm's total liquidity risk. Firms with greater liquidity risk are monitored more often, causing direct and indirect monitoring costs (i.e., expected costs of credit line revocation) to increase, and as a result are particularly likely to forego monitored liquidity insurance and to switch to self-insurance (cash holdings).

We extend the model to allow firms to demand liquidity not only to absorb negative profitability shocks, but also to pursue additional investment opportunities. The financing of future investments interacts with liquidity shock insurance through two channels. First, the cost of credit line revocation increases because credit line revocation both limits the continuation of existing projects, and stops the firm from undertaking new investments. Second, future growth opportunities may provide incentives for firms to avoid illiquidity transformation independently of monitoring. The first channel is particularly relevant for firms that tend to have investment opportunities in states with low cash flows (in which credit lines are likely to be revoked). The second channel is particularly relevant for firms that tend to have investment opportunities in high cash flow states (whose probability decreases with illiquidity transformation). This set up implies that firms with *low hedging needs* (high correlation between cash flows and investment opportunities) are less likely to use cash relative to credit lines, and are also less likely to require credit line covenants and revocation when using credit lines for liquidity insurance.

Overall, our model provides two sets of empirically testable predictions, one set dealing with the relationship between liquidity risk and liquidity management, and another set dealing with the relationship between hedging needs, liquidity management, and credit line covenants and revocations. We test these predictions using a novel dataset on credit lines from Capital IQ (CIQ). The data cover a large sample of firms in the United States for the period of 2002 to 2011. CIQ compiles detailed information on capital structure and debt structure by going through financial footnotes contained in firms' 10-K Securities and Exchange Commission (SEC) filings. In particular, CIQ contains detailed information on the drawn and undrawn portions of lines of credit.

We test the implication that an increase in liquidity risk decreases reliance on credit lines using two different identification strategies. We first exploit the downgrade of General Motors (GM) and Ford in 2005 as a quasi-natural experiment. The downgrade came as an exogenous and unexpected shock, especially for firms not in the auto sector. Acharya, Schaefer and Zhang (2008) examine the GM-Ford downgrade in detail, and show that it led to a market-wide sell-off of the corporate bonds issued by these two firms. The downgrade had a significant impact on inventory risk faced by financial intermediaries that operated as market makers for the securities issued by the two auto makers. The resulting effect on corporate bond prices went beyond the bonds of GM and Ford and of other producers in the auto sector, creating a widespread increase in liquidity risk that affected firms that relied on publicly-traded bonds for their financing.

Consistent with the model's predictions, we find that "treated" firms that experienced an exogenous increase in liquidity risk due to the GM-Ford downgrade – specifically, firms that relied on bonds for financing in the pre-downgrade period – moved out of credit lines and into cash holdings in the aftermath of the downgrade, relative to the set of "control" firms.[1] More precisely, we find that while "treated" firms had on average around 7.4% less cash holdings as a share of total liquidity relative to "control" firms before the GM-Ford downgrade, following the downgrade their cash holdings were on average around 4% higher as a share of total liquidity relative to "control" firms.[2] Further, we find that there is both an increase in cash holdings and a decrease in credit line usage for the "treated" firms relative to the "control" firms. A placebo test in a period outside of the downgrade episode reveals no such effect.

Given that the shift towards cash for bond-dependent firms happens only following the GM-Ford downgrade, any alternative explanation for our results must also predict a similar shift that is specific to the downgrade episode. While we find this possibility implausible, we cannot entirely rule it out given that a firm's bond-dependence is endogenously determined. Thus, to provide additional evidence for a causal effect of liquidity risk on liquidity management, we study the impact of mutual fund redemptions on corporate liquidity management. We follow Edmans, Goldstein and Jiang (2012) and construct a measure of price pressure associated with outflows from mutual funds. Edmans et al use changes in stock prices that are driven by large outflows by fund investors to measure variation in equity values that are not driven by firm fundamentals. In our context, mutual fund outflows should only affect liquidity management through its effect on equity mispricing. Firms that are under price pressure will find it more costly to access equity financing and as a result face greater liquidity risk in the aftermath of large fund redemptions. Consistent with this hypothesis, we find that as downward price pressure increases, firms shift from credit lines to cash holdings in their liquidity management. This evidence provides further support to the empirical implications of our model.

Next, we provide novel evidence linking corporate hedging needs to liquidity management

[1] We measure bond dependence at the 3-digit SIC industry level, to prevent firm-level unobserved characteristics that vary within an industry from driving our results.

[2] Since ours is a difference-in-differences (DID) empirical design, time-invariant variables (even unobservable ones) are differenced out and do not compromise identification.

and credit line contracting. Following existing literature (Acharya, Almeida and Campello (2007) and Duchin (2010)), we measure hedging needs by correlating firm cash flows with investment opportunities. We measure investment opportunities using two alternative industry-level proxies, median industry annual investment activities and median industry Tobin's Q. In addition we collect information from LPC Dealscan on covenants attached to new credit lines issued to the firms in our sample and from Nini, Smith and Sufi (2010) on covenant violations.

In line with the predictions of our model, we find that low-hedging needs firms (those with the highest correlations between cash flows and investment opportunities) are the most likely to use credit lines. Depending on the measure chosen, moving from the bottom quintile to the top quintile of hedging-needs is associated on average with a decrease of between 19.5% and 27.8% in the probability of having a line of credit. The credit lines of low hedging-needs firms are also less likely to contain covenants, and to be revoked by banks. These findings support the model's implications that credit lines are less costly for low-hedging needs firms, and that for such firms, the credit line provider (the bank) is less likely to retain revocation rights through covenants and to exercise them. In particular, these findings stem uniquely from the feature of our model that firms taking out lines of credit are monitored by banks that provide the lines by inclusion of contract terms such as covenants and by invoking them ex post; the high expected cost of monitoring and the ex-post revocation costs for high-hedging needs firms (which face a greater illiquidity transformation problem) induce these firms in equilibrium to rely more on cash rather than on lines of credit.

While we see the new identification strategy for the liquidity risk tests and the hedging needs tests (which together provide support for lines of credit being a form of monitored finance) as the main empirical contributions of the paper, we show that our results are also consistent with existing empirical evidence. Our main goal is to show that the Capital IQ data delivers results that closely resemble those obtained with other datasets. For example, Capital IQ data confirm earlier findings that profitable, safer, low Q and high tangibility firms are more likely to have credit lines and less likely to use cash for liquidity management. Credit line users tend to have higher bond ratings, and are more likely to have a rating when compared to firms that use cash for liquidity management. We also confirm Sufi's (2009) finding that credit lines tend to get revoked following decreases in profitability. In addition, we find evidence that credit line drawdowns are relatively infrequent relative to cash reductions in situations in which firms are likely to have a liquidity need, which we define as a year in which profitability is negative. For instance, the likelihood of a credit line drawdown to fund a liquidity shock (among credit line users) is close to 10 times lower than the likelihood of a reduction in cash holdings to fund a similar liquidity shock among cash users. This result shows that the *ex-post* usage of credit lines and cash to meet liquidity needs is consistent with *ex-ante* differences in liquidity risk exposure across firms.

Our evidence is related to Sufi's (2009) result that firms with low profitability and high cash flow risk are less likely to use credit lines and more likely to use cash for liquidity management because they face a greater risk of covenant violation and credit line revocation.[3] Our theory and tests provide the new insight that credit line revocation following negative profitability shocks can be an optimal way to incentivize firms to not strategically increase liquidity risk of projects and banks to monitor firms to contain the illiquidity transformation problem.[4]

Our findings on the role of hedging needs for liquidity management are related to those in Disatnik, Duchin and Schmidt (2010). They find that firms that are more exposed to traded sources of risk such as foreign currency and commodity price risk (due to their industry affiliation) use more derivatives-based hedging. These firms are also more likely to use credit lines rather than cash to manage the liquidity risk that remains after derivatives usage. While we do not explicitly model the firm's demand for derivatives, this result is consistent with our theory. Industry-related derivatives usage reduces the probability that the firm will face a cash shortfall, and thus the firm's liquidity risk. According to our model, this firm will face lower monitoring costs and is more likely to demand monitored liquidity insurance through credit lines. In this sense, our model can provide an explanation for Disatnik, Duchin and Sensoy's (2010) results.

The theory in our paper is closely related to the literature that focuses on "bank specialness", such as Fama (1986), Houston and James (1996) and Holmstrom and Tirole (1997). In these models, the bank improves resource allocation by creating pledgeable income through a reduction in private benefits, improved project screening, and other mechanisms. In contrast, in our paper, the special role of the bank is to provide monitored credit lines that allow the bank to control firms' liquidity choices. Kashyap, Rajan and Stein (2002) and Gatev and Strahan (2006) do focus on liquidity provision by banks through credit lines. These papers suggest a different rationale for credit lines (diversification synergies with deposits). Our model can be considered as nesting the view of banks as efficient providers of liquidity insurance under the view of banks as efficient monitors.

We start in the next section by introducing our model of credit line revocation as an incentive device for the firm to commit to a liquid investment choice. Section 3 summarizes

[3]The growing empirical literature on the role of credit lines in corporate finance also includes Yun (2009), Campello, Giambona, Graham, and Harvey (2010), and Acharya, Almeida and Campello (2012).

[4]This insight distinguishes our paper from previous theoretical work on corporate liquidity management such as Acharya et al. (2007).

the empirical implications of the model. Section 4 introduces and presents our empirical analysis, and Section 5 concludes the paper.

2 The model

Our model introduces two innovations to the standard liquidity management model of Holmstrom and Tirole (1998). First, we allow the firm to engage in illiquidity-seeking behavior after acquiring insurance against liquidity shocks, to explore the role of credit line revocation as a monitoring mechanism. Second, we introduce a future investment opportunity whose financing must be planned for. The correlation between the probability of arrival of this investment opportunity and short-term cash flow varies across firms. This innovation allows us to characterize the impact of hedging needs on the firm's liquidity policy.

2.1 Basic structure

The timing of the model is depicted in Figure 1. At the initial date (date 0), each firm has access to an investment project that requires fixed investment I at date 0 and an additional investment at date 1, of uncertain size (the firm's liquidity need). The date-1 liquidity need can be either equal to ρ, with probability $\widehat{\lambda}$, or 0, with probability $(1-\widehat{\lambda})$. We can interpret state $\widehat{\lambda}$ $(1-\widehat{\lambda})$ as a state in which the firm produces low (high) cash flow at date-1.[5]

FIGURE 1 ABOUT HERE

In state $\widehat{\lambda}$, a firm will only continue its date-0 investment until date 2 if it can meet its date-1 liquidity need. Otherwise the firm is liquidated and the project produces nothing. If the firm continues, it produces total expected date-2 cash flow equal to $\widehat{\rho_1}$ from the original project. As in Holmstrom and Tirole (1998), the basic friction in this model is that some of this expected cash flow is not pledgeable to outside investors. In short, we assume that conditional on continuation, the original project produces pledgeable income equal to $\widehat{\rho_0} < \widehat{\rho_1}$. In the appendix we describe a moral hazard structure (identical to that in Holmstrom and Tirole) that generates limited pledgeability.

If the firm continues, it also has access at date-1 to an additional investment opportunity that arrives with probability υ. This date-1 investment requires an investment of τ and produces a date-2 cash flow of $\rho^{\tau} > \tau$. For simplicity, we assume that this date-2 cash flow generates zero pledgeable income (this assumption can be easily relaxed).

[5] To see this, let the date-0 investment produce a date-1 cash flow equal to $\widetilde{r}$, which is random. The cash flow $\widetilde{r}$ can be either equal to r, with probability $(1-\widehat{\lambda})$, or 0, with probability $\widehat{\lambda}$. The required date-1 investment is equal to I_1. If we let $r = I_1$, we obtain the set up above with $\rho = I_1$.

The probability of arrival of the new investment opportunity depends on the date-1 state. It is equal to $\upsilon = \upsilon^H$ in state $(1 - \widehat{\lambda})$, and $\upsilon = \upsilon^L$ in state $\widehat{\lambda}$. Notice that the key difference between the liquidity need ρ, and the investment opportunity τ is that τ can arrive in both states of the world, whereas the liquidity need ρ arises only when firm cash flows are low (state λ'). The probability $\widehat{\lambda}$ is endogenous. Specifically, $\widehat{\lambda}$ is either equal to λ, or equal to $\lambda' > \lambda$. The manager chooses the probability $\widehat{\lambda}$ after the initial investment has been made. The choice of probability is unobservable to outside parties at date-1, who can only observe whether or not the firm has a liquidity need at date-1 (e.g., ρ is observable). There is no discounting.

The manager's choice of $\widehat{\lambda}$ impacts the original project's cash flows and pledgeable income in the following way. If the manager chooses $\widehat{\lambda} = \lambda'$, the date-2 cash flow $\widehat{\rho_1}$ is equal to ρ_1'. If the manager chooses $\widehat{\lambda} = \lambda < \lambda'$, the date-2 cash flow is $\rho_1 < \rho_1'$. This structure allows us to interpret the choice of $\widehat{\lambda} = \lambda'$ as the "illiquidity transformation" by the manager, since it results in a high date-2 cash flow conditional on continuation, but also on a greater probability of a liquidity shock at date-1. We refer to the choice of $\widehat{\lambda} = \lambda$ as the "liquid project", and the choice of $\widehat{\lambda} = \lambda'$ as the "illiquid project".

To economize on notation denote the following quantities:

$$\begin{aligned} (1-\lambda)\upsilon^H + \lambda\upsilon^L &\equiv \overline{\upsilon}, \\ (1-\lambda')\upsilon^H + \lambda'\upsilon^L &\equiv \overline{\upsilon}'. \end{aligned} \tag{1}$$

Thus, $\overline{\upsilon}$ ($\overline{\upsilon}'$) is the expected arrival rate of the new investment opportunity when the manager chooses λ (λ'). Notice that since $\lambda < \lambda'$, $\overline{\upsilon} > \overline{\upsilon}'$.

We make the following assumptions:

$$\rho_1 - I - \lambda\rho + \overline{\upsilon}(\rho^\tau - \tau) > \rho_1' - I - \lambda'\rho + \overline{\upsilon}'(\rho^\tau - \tau) > 0 \tag{2}$$

$$\rho_0 = \rho_0', \tag{3}$$

$$\max[I + \lambda\rho + \overline{\upsilon}\tau,\, I + \lambda'\rho + \overline{\upsilon}'\tau] \leq \rho_0. \tag{4}$$

$$\rho_0 < \rho < \rho_1 \tag{5}$$

$$(1 - \upsilon^L)\tau < \rho \tag{6}$$

The first assumption means that the liquid project has higher NPV than the illiquid project, net of monitoring costs. But the illiquid project is also positive NPV. The second assumption means that both the liquid and the illiquid project produce the same pledgeable income ρ_0.[6] The third assumption means that both the liquid and the illiquid project generate enough pledgeable income to fund the initial investment and the date-1 investment opportunity. The fourth assumption means that conditional on the date-1 liquidity shock, the firm does not have sufficient pledgeable income to continue the original project ($\rho_0 < \rho$) though continuation is efficient irrespective of the new investment opportunity ($\rho < \rho_1$). The fifth assumption captures the intuitive condition that the firm's demand for liquidity should be greater in the low cash-flow state, as we will see below.

2.2 Liquidity management and illiquidity transformation incentives

The firm can manage its liquidity either using a bank credit line or cash holdings.[7] As in Holmstrom and Tirole (1998), the firm holds cash by buying a riskless, liquid security (such as a Treasury bond) at date-0. The price of the bond is equal to q, which we take as exogenous. Holmstrom and Tirole endogenize the cost of cash and show that if the demand for liquid securities is high enough the firm may need to pay a liquidity premium to transfer cash across time (that is, $q > 1$ in equilibrium). In what follows we assume that $q = 1$, such that there is no liquidity premium. We note, however, that the model implications also hold when $q > 1$. In Section 3 we discuss the implications of the liquidity premium for the model predictions.

The credit line works similarly to an insurance contract. The firm pays a commitment fee y to the bank in the states in which it does not need additional liquidity, in exchange for the right to draw on additional funds (up to a maximum equal to w) in other states.[8] We assume that the bank can provide the credit line at zero deadweight cost, that is, the bank can offer contracts that correspond to actuarially fair insurance).[9]

Assume that in order to implement the liquid project, the firm raises capital to finance the initial investment and opens a credit line with the bank. In exchange for the financing,

[6] In the moral hazard framework of the appendix, this condition is a consequence of the assumption that illiquidity transformation increases both the project's verifiable cash flow and private benefit in a way that leaves pledgeable income constant. Please refer to appendix 6.1.

[7] The firm's ability to use a credit line to manage liquidity distinguishes our theory from Acharya, Almeida and Campello (2007), who only consider cash as a liquidity management device.

[8] In this model the firm does not need to repay the credit line drawdown w, that is, the drawdown of the credit line generates no liability. More generally, we can interpret w as the difference between the credit line drawdown, and the present value of the repayments from the firm to the bank. As discussed by Tirole (2006), the key insurance feature of the credit line is that it forces the bank to make loans that are (ex-post) negative-NPV for the bank. The bank breaks even through commitment fees y.

[9] Acharya, Almeida and Campello (2012) show that banks should be able to offer fair insurance to firms that have idiosyncratic liquidity risk, but may need to increase the cost of credit line provision if liquidity risk is correlated across firms. In Section 3 we discuss the impact of such costs for the model implications.

the firm commits to making a payment D to the bank out of the date-2 cash flow.[10] The bank's break-even constraint requires that:

$$(1-\lambda)\left[(1-\upsilon^H)D+\upsilon^H(D-\tau)\right]+\lambda\left[(1-\upsilon^L)D+\upsilon^L(D-\tau)-\rho\right]=I, \tag{7}$$

while the pledgeability constraint requires that $D \leq \rho_0$. Notice that the firm makes payments to the bank in the states in which it does not need additional liquidity (such as state $(1-\lambda)(1-\upsilon^H)$, in exchange for additional liquidity transfers in the other states (such as state λ). As long as equation 4 holds, such that $I+\lambda\rho+\overline{\upsilon}\tau \leq \rho_0$, it is possible to find a payment $D \leq \rho_0$ such that the break-even constraint is satisfied.

Once this contract is in place, does the firm have incentives to stick to the liquid investment? Doing so produces a payoff for the firm equal to:

$$(1-\lambda)(\rho_1+\upsilon^H\rho^\tau-D)+\lambda(\rho_1+\upsilon^L\rho^\tau-D)=\rho_1-D+\overline{\upsilon}\rho^\tau. \tag{8}$$

That is, the firm uses the credit line to continue the project and fund the new investment, and repays D to the bank in both states. If the firm deviates and shifts funds into the illiquid project, the payoff is:

$$(1-\lambda^{'})(\rho_1^{'}+\upsilon^H\rho^\tau-D)+\lambda^{'}(\rho_1^{'}+\upsilon^L\rho^\tau-D)=\rho_1^{'}-D+\overline{\upsilon}^{'}\rho^\tau. \tag{9}$$

Deviation thus pays off for the firm if $\rho_1^{'}+\overline{\upsilon}^{'}\rho^\tau > \rho_1+\overline{\upsilon}\rho^\tau$. Under this deviation the firm faces a liquidity shock with greater probability ($\lambda^{'} > \lambda$). This increase in the cost of the project is irrelevant for the firm once it has secured a fully committed credit line with the bank. The bank must finance the liquidity shock ρ with greater probability, but is not compensated for it (the firm still pays D).[11] Thus, the firm may have incentives to deviate the project funds into the illiquid investment.[12]

2.3 Bank monitoring and the role of credit line revocation

To avoid illiquidity transformation, the firm may need a commitment device. This mechanism creates a role for *monitored* liquidity insurance. We assume that the monitor (the bank) can

[10] This payment covers both the initial investment and the commitment fee on the credit line.

[11] Illiquidity transformation is similar to, but different from Jensen and Meckling's (1976) risk-shifting problem. In Jensen and Meckling, a firm with high leverage may have incentives to take risky investments that shift value from debt to equity. The main implication is that firms prone to risk-shifting should have low leverage ratios. In contrast, the main implication of our model is that firms may require monitored liquidity insurance in the form of a revocable credit line to control incentives to engage in illiquidity transformation. In particular, this implication holds irrespective of the firm's leverage ratio.

[12] One may wonder whether the firm can use derivatives to mitigate the incentives to engage in illiquidity transformation. A call option on firm cash flows, for example, could transfer the benefits of success to outside investors. Such a strategy would not work in our set up, because any cash flow in excess of the pledgeable income ρ_0 cannot be paid out to investors because of the underlying moral hazard problem.

pay a cost c at date-1 to receive a signal s that gives information about the manager's liquidity choice. Specifically we have that:

$$\begin{aligned} \text{Prob}(s &= s^{'}/\widehat{\lambda} = \lambda) = \mu < 1 \\ \text{Prob}(s &= s^{'}/\widehat{\lambda} = \lambda^{'}) = 1. \end{aligned} \tag{10}$$

That is, if the firm chooses $\widehat{\lambda} = \lambda^{'}$, bank monitoring will reveal that the firm made the wrong choice. But the bank receives an imperfect signal in case the firm makes the correct choice. This signal s is verifiable, so contracts that are contingent on s are feasible.

We do not assume that the bank can commit to monitor. Rather, the bank will monitor only if it has sufficient incentives to do so. Because credit line drawdowns are larger in the low cash flow state (state $\widehat{\lambda}$), the bank's incentive to monitor is greater in this state. Suppose the firm has committed to a payment $D_M \leq \rho_0$ to the bank.[13] If the manager chooses $\widehat{\lambda} = \lambda$, the bank has incentives to monitor in the low cash flow state when:

$$\mu(\rho + \upsilon^L \tau - D_M) > c. \tag{11}$$

The expression $\rho + \upsilon^L \tau - D_M$ is the difference between the expected credit line drawdown $\rho + \upsilon^L \tau$, and the payment that the firm makes to the bank, D_M. This expression is greater than zero by assumption 5 and because $D_M \leq \rho_0$. Thus, revoking the credit line (with probability μ) generates a benefit for the bank. As long as the expected benefit from revocation is greater than the monitoring cost, the bank will have incentive to monitor. This incentive to monitor arises because the credit line allows the firm to access more funding than what its pledgeable income allows. The insurance role of the credit line and bank incentives to monitor are inherently linked.

In contrast, the bank's incentives to monitor in the high cash flow state are weaker because the firm's demand for liquidity is lower. In that state, the credit line may be required to help fund the new investment opportunity, if $\tau > \rho_0$. Thus, the potential benefit of monitoring in the high cash flow state is given by $\mu(\tau - D_M) - c$. Since $\tau < \rho + \upsilon^L \tau$ (by assumption 6), the incentives to monitor will be greater in the low cash flow state.

Given than the bank is expected to monitor in the low cash flow state, does the firm have incentives to avoid illiquidity transformation? The firm now anticipates that if its cash flow is low, the bank will monitor and may revoke the credit line. Since illiquidity transformation increases the probability of the low cash flow state, the firm has a stronger incentive to avoid it when it expects the bank to monitor. As we show in the proof to Proposition 1 below, if

[13] D_M is the promised payment to the bank in the monitored solution. We solve for D_M below.

condition 25 holds the optimal contract can rely on credit line revocation to provide incentives for the firm to avoid illiquidity transformation.

In particular, this framework helps explain why credit line revocation tends to happen precisely in states of the world when the firm needs the credit line the most. Monitoring happens in low cash flow states because the bank gains the most from credit line revocation in these states, and because this revocation provides incentives for the firm to avoid actions that increase the probability of low cash flow states, such as illiquidity transformation. On the other hand, the monitored credit line entails both the direct monitoring cost c and the indirect costs of credit line revocation, which arise from the bank's ability to revoke access to the credit line with probability μ. The resulting trade-off generates the main predictions of the theory, which we derive and explain below.

2.4 Main results

We start by deriving the firm's payoffs under the monitored credit line, and when it uses cash to manage liquidity.

2.4.1 Project payoffs and optimal project choice

We first derive the firm's payoff if it chooses the liquid project.

Proposition 1 *If $\rho_1^{'} + \overline{\upsilon}^{'}\rho^{\tau} \leq \rho_1 + \overline{\upsilon}\rho^{\tau}$, then monitoring is not required and the payoff of the liquid project is:*

$$U_L \equiv \rho_1 - I - \lambda\rho + \overline{\upsilon}(\rho^{\tau} - \tau). \tag{12}$$

If $\rho_1^{'} + \overline{\upsilon}^{'}\rho^{\tau} > \rho_1 + \overline{\upsilon}\rho^{\tau}$, the liquid project can only be implemented with monitoring. Let D_M be defined as:

$$(1-\lambda)\left[D_M - \upsilon^H\tau\right] + \lambda(1-\mu)(D_M - \upsilon^L\tau - \rho) = I. \tag{13}$$

If equations 11 and 25 hold, the payoff of the liquid project with monitoring is given by:

$$U_L^* = U_L - \lambda\left[c + \mu\left[\rho_1 - \rho + \upsilon^L(\rho^{\tau} - \tau)\right]\right]. \tag{14}$$

If either equation 11 or equation 25 does not hold, the liquid project cannot be implemented.

All results are proved in the appendix. The condition $\rho_1^{'} + \overline{\upsilon}^{'}\rho^{\tau} \leq \rho_1 + \overline{\upsilon}\rho^{\tau}$ establishes whether the firm can access fully committed liquidity insurance or not. If the incentive to engage in illiquidity transformation is high $(\rho_1^{'} + \overline{\upsilon}^{'}\rho^{\tau} \leq \rho_1 + \overline{\upsilon}\rho^{\tau})$, then implementing the liquid project requires monitoring. As long as monitoring is incentive compatible both for the firm and the bank, the liquid project can be implemented resulting in the payoff U_L^*. The term $\lambda\left[c+\mu\left[\rho_1-\rho+\upsilon^L(\rho^\tau-\tau)\right]\right]$ denotes the (ex-ante) cost of monitoring. It comprises the direct monitoring cost and the cost of credit line revocation, which is the loss of the original project and the new investment opportunity with probability μ. Finally, if monitoring is not incentive compatible for both for the firm and the bank, then the liquid project cannot be implemented when there are incentives to engage in illiquidity transformation.

If the firm chooses the illiquid project to begin with, then illiquidity transformation is not an issue. Given assumptions 2 and 4, the illiquid project can always be implemented:

Proposition 2 *The payoff of the illiquid project is given by:*

$$U_C = \rho_1^{'} - \lambda^{'}\rho - I + \overline{\upsilon}^{'}(\rho^\tau - \tau). \tag{15}$$

In this case the firm promises a payment $D^{'}$ to outside investors, which is given by:

$$(1-\lambda^{'})(D^{'} - \upsilon^H\tau) + \lambda^{'}(D^{'} - \upsilon^L\tau - \rho) = I. \tag{16}$$

The next result follows from Propositions 1 and 2:

Corollary 1 *If $\rho_1^{'}+\overline{\upsilon}^{'}\rho^\tau \leq \rho_1+\overline{\upsilon}\rho^\tau$, the firm chooses the liquid project. If $\rho_1^{'}+\overline{\upsilon}^{'}\rho^\tau > \rho_1+\overline{\upsilon}\rho^\tau$, then the firm chooses the liquid project if equations 11 and 25 hold, and $U_L^* > U_C$. It chooses the illiquid project if $U_L^* \leq U_C$, or if either equation 11 or equation 25 does not hold.*

If $\rho_1^{'}+\overline{\upsilon}^{'}\rho^\tau > \rho_1+\overline{\upsilon}\rho^\tau$ then the liquid project requires monitoring. Thus, the firm chooses the liquid project if monitoring is feasible and the monitoring cost is not too high, and the illiquid project otherwise.

2.4.2 Implementation using cash and credit lines

We now characterize the implementation of the liquid and illiquid projects using cash and credit lines. We focus first on the case in which monitoring is both required for the implementation of the liquid project and incentive compatible both for the firm and for the bank. In the extension section below (Section 2.4.4) we discuss the implications that arise from studying other cases.

Proposition 3 *If $U_L^* > U_C$, the firm implements the liquid project with a monitored credit line of size $\rho+\tau-\rho_0$. The credit line is revoked with probability μ if the firm produces low date-1 cash flow (in state λ). If $U_L^* \leq U_C$, the firm implements the illiquid project by holding an amount of cash equal to $C = \rho+\tau-\rho_0$.*

If illiquidity transformation is an issue, the firm must employ monitored liquidity insurance to implement the liquid project. The natural solution is then to use a revocable credit line which gives the bank the right to deny access to the credit line if it receives a signal that the firm has engaged in illiquidity transformation.[14]

In principle, monitored liquidity insurance can also be implemented with cash that is held by the firm, provided that the bank or another outside investor can monitor the firm and control whether the firm can use the cash to finance expenditures. However, given that the firm has the default control of cash in this case, such a contract must specify exactly, and in an enforceable way, when the firm has priority over the usage of cash, and when the cash must be returned to the bank. In general, this solution will not be as robust as the bank-provided credit line.[15]

In order to illustrate the issues that might arise, suppose for example that the firm learns about the liquidity shock ρ before the bank does.[16] Under the credit line implementation, the firm must contact the bank to request a drawdown of the credit line since the firm does not have sufficient resources to pay for the liquidity shock. This contact would prompt the bank to monitor, and possibly revoke the credit line (as modeled above). Under an alternative cash implementation, since the firm has control over the cash, the contract would need to ensure that the firm has correct incentives to report the liquidity shock before using the cash to pay for it. If the firm deviates from the contract and spends the cash, the bank can for example demand immediate payment and liquidate the firm. However, in this case liquidation becomes (ex-post) inefficient for the bank since continuation produces pledgeable income ρ_0, while liquidation produces nothing. The bank has ex-post incentives to renege from monitoring and liquidation, and thus the monitored solution breaks down.

While cash is not the best option to implement the liquid project when monitored liquidity insurance is required, it does allow the firm to implement the illiquid project. In particular, cash is a better alternative for the firm in this case than a non-monitored credit line. The problem with the credit line alternative is that monitoring is conditionally efficient for the bank in state λ'. In fact, the bank's incentives to monitor are very strong if the firm chooses

[14] This result also implies that the firm would not fully substitute the monitored credit line for derivatives, even if the underlying source of cash flow risk is traded on the market. Unlike credit lines, derivatives do not allow for monitoring and revocation. Full insurance through derivatives would thus induce firms to make illiquid investments ex-ante, in the expectation that investors will pay for cash shortfalls ex-post.

[15] Our model explains why the credit line may have an unique role in implementing monitored liquidity insurance, but it does not explain why credit lines are provided by banks. See Kashyap, Rajan and Stein (2002), Gatev and Strahan, (2005), and Gatev, Schuermann, and Strahan, (2009) for explanations that focus on synergies between the deposit-taking and the credit line-providing roles of banks.

[16] For example, the firm may have inside information about date-1 cash flows.

the illiquid project, since the credit line is revoked with probability one given monitoring.[17] Unless the bank can perfectly commit *not to* monitor, the firm risks being liquidated with probability one in state λ' under credit line implementation.

This result suggests that cash-based liquidity management will tend to be associated with illiquid projects that require frequent liquidity infusions. Firms that endogenously choose to invest in projects with high liquidity risk will find it optimal to self-insure against such shocks, while firms that choose to invest in projects with low liquidity risk manage liquidity through a monitored credit line to ensure that they do not engage in illiquidity transformation after the bank has provided liquidity insurance. Below, we show that the link between liquidity risk and liquidity management extends to a case in which firms are heterogeneous with respect to liquidity risk.

2.4.3 Introducing heterogeneity in liquidity risk and hedging needs

We now introduce two sources of firm heterogeneity in the model, with the goal of deriving testable empirical implications.

Liquidity risk and the choice between cash and credit lines Suppose first that there are two types of firms, L and H. Firm L has lower liquidity risk than firm H irrespective of project choice, that is, $\widehat{\lambda}_L < \widehat{\lambda}_H$ (which is equivalent to saying that $\lambda_L < \lambda_H$ and $\lambda_L' < \lambda_H'$). This difference in liquidity risk can be interpreted as arising from firm characteristics such as the risk of the underlying business and the correlation between cash flows and investment needs. Specifically we make the following assumption:

$$\lambda_j' = \lambda_j + t, \text{ for } j = L, H \ . \tag{17}$$

This assumption means that the effect of illiquidity transformation on the probability of the liquidity shock is the same for both types of firm. This assumption is sufficient but not necessary for our results - all that is needed is that the potential increase in illiquidity risk is not much larger for firms of type H. Given this assumption, the following result follows from the analysis in the previous section:

Proposition 4 *Firms with low liquidity risk (type L) are more likely to choose credit lines for liquidity management, while firms with high liquidity risk (type H) are more likely to choose cash.*

[17] The bank would benefit from monitoring if $\rho + \upsilon^L \tau - D' > c$.

The intuition for this result is straightforward. As the probability of the liquidity shock increases, monitoring becomes increasingly expensive due to the direct monitoring cost and revocation of credit line access. Thus, firms with high liquidity risk prefer to avoid monitored liquidity insurance and use cash for liquidity management.

Hedging needs and the choice between cash and credit lines We now allow firms to vary with respect to their correlation between date-1 cash flows and the investment opportunity τ. Specifically, we compare two types of firms. A firm with low hedging needs (LHN) has $\upsilon^H > \upsilon^L$, and consequently $\overline{\upsilon}' - \overline{\upsilon} < 0$ (notice that $\overline{\upsilon}' - \overline{\upsilon} = -(\upsilon^H - \upsilon^L)(\lambda' - \lambda)$). This firm has a greater probability of having the investment opportunity τ in the high cash flow state $(1 - \widehat{\lambda})$. A firm with high hedging needs (HHN) has $\upsilon^H = \upsilon^L \equiv \upsilon$, or the same probability of the investment opportunity in both states. We let $\upsilon = \overline{\upsilon} > \upsilon^L$, so that the expected arrival of the investment opportunity is identical for the two types of firms. This set up also implies that $\overline{\upsilon}' = \overline{\upsilon}$ for the high hedging-needs firm. Both firms have the same probability $\widehat{\lambda}$, that is, the implications of this section hold while controlling for variation in liquidity risk. We can show the following result:

Proposition 5 *The firm with low hedging needs is more likely to use credit lines for liquidity management, when compared to the firm with high hedging needs. That is,* $(U_C - U_L^*)_{HHN} >$ $(U_C - U_L^*)_{LHN}$. *Thus, if* $(U_C - U_L^*)_{HHN} >$ *is lower than zero, then* $(U_C - U_L^*)_{LHN}$ *must be lower than zero.*

There are two effects that differentiate low and high hedging-needs firms. First, the firm with high hedging needs faces a greater cost of using the monitored credit line because its investment opportunities tend to be concentrated in states with low cash flow (in which the credit line is likely to be revoked). Second, the firm with low hedging needs has a greater incentive to avoid the low cash flow state because its investment opportunities are positively correlated with cash flows. This effect increases the benefit of the liquid investment and the monitored credit line for the firm with low hedging needs.

2.4.4 Extensions

In this section we consider three extensions of the basic framework above. First we analyze the implementation of cases in which the incentives to engage in illiquidity transformation are weak. Second, we analyze the implications of the case in which monitoring may not be incentive compatible for both the firm and the bank. Third, we extend the model to allow for a continuous distribution of liquidity shocks. The goal is generate a link between pledgeable income and liquidity risk.

Hedging needs and fully committed liquidity insurance If $\rho_1^{'} + \overline{\upsilon}^{'} \rho^{\tau} \leq \rho_1 + \overline{\upsilon} \rho^{\tau}$, then illiquidity transformation is not an issue. In such a case, corollary 1 shows that the liquid project is always chosen. Since monitoring is not required to implement the optimal solution in this case, the firm can access fully committed liquidity insurance.

This case is more likely to happen when $\overline{\upsilon} - \overline{\upsilon}^{'}$ is high. Since $\overline{\upsilon} - \overline{\upsilon}^{'} = (\upsilon^H - \upsilon^L)(\lambda^{'} - \lambda)$, this difference increases as hedging needs decrease (that is, as $\upsilon^H - \upsilon^L$ becomes larger). Thus, firms with low hedging needs should find it easier to obtain fully committed liquidity insurance for liquid projects. This result arises from the same incentive effect mentioned above in the proof to Proposition 5: the firm with low hedging needs has a greater incentive to avoid the low cash flow state because its investment opportunities are positively correlated with cash flows.

In the absence of other frictions, the firm can use both cash or a credit line to implement the liquid project in this case. However, even a small liquidity premium would drive the firm to prefer a fully committed credit line to cash. The implication that follows is that fully committed credit lines should be more common for low-hedging needs firms, which are less likely to require monitoring and credit line revocation.

The other implications of the model continue to hold once we allow for this case. In particular, the relationship between hedging needs and the choice of liquidity mechanism (Proposition 5) is unchanged, since fully committed liquidity insurance is more likely to be optimal for low-hedging needs firms.

Monitoring not incentive-compatible If there are incentives for illiquidity transformation ($\rho_1^{'} + \overline{\upsilon}^{'} \rho^{\tau} > \rho_1 + \overline{\upsilon} \rho^{\tau}$) but monitoring is not incentive compatible (that is, if either 11 or 25 does not hold), the liquid project cannot be implemented and the firm will choose the illiquid project (Corollary 1). This particular case is more likely to arise when the monitoring cost c or the payoff of the illiquid project $\rho_1^{'}$ are high.

As in Section 2.4.2, the firm should prefer to use cash to provide liquidity insurance for the illiquid project. In this sense, the key implication of Section 2.4.2 continues to hold if we allow some firms not to satisfy the incentive compatibility conditions for monitoring: firms that choose to invest in high liquidity risk projects will find it optimal to self-insure against such shocks using cash, while firms that choose to invest in projects with low liquidity risk manage liquidity through a monitored credit line.

Pledgeable income and liquidity risk In the model above the probability λ is an exogenous parameter that establishes the probability that the firm will suffer a liquidity shortfall. This probability should be a function of variables such as the firm's cash flow risk and the firm's ability to raise external finance. The cash flow risk interpretation directly matches the model presented above (see footnote 5). However, in the model there is no link between the firm's ability to raise external finance (captured by ρ_0) and liquidity risk.

This lack of link between liquidity risk and pledgeable income is an artificial feature that is caused by the binomial structure of the model. It is straightforward to extend the model to a more general case in which the date-1 liquidity shock $\widehat{\rho}$ can assume values in a range $[0, \rho^{\max}]$ according to a distribution function $\widehat{F}(.)$. This extension allows us to derive implications relating pledgeable income and the choice between cash and credit lines.[18]

The main result, which we prove in the appendix, is that a decrease in pledgeable income ρ_0 makes it more likely that the firm will choose cash instead of the credit line. The intuition for this result is that a decrease in pledgeable income increases the firm's liquidity risk (the probability that it will require liquidity infusions from the credit line), and consequently the monitoring cost of the credit line. As pledgeable income decreases, the bank's incentive to monitor the firm increases, increasing direct and indirect monitoring costs.

3 Empirical implications

The first set of empirical predictions of the model focuses on the role of revocations of lines of credit as a monitoring mechanism to prevent illiquidity transformation by firms, and the implications of this monitoring mechanism for optimal liquidity management. The key implication that we test is that:

1. *An increase in liquidity risk causes firms to switch from credit lines to cash for their liquidity management.*

Firms that face a high risk of facing credit line revocation (those with high liquidity risk) find it more costly to employ monitored liquidity insurance and switch to cash holdings.[19] A

[18] For simplicity, in this extension we shut down the new investment opportunity by making $\upsilon = 0$.

[19] As discussed in Section 2.2, this implication is derived under the assumptions that the firm can carry cash without incurring a liquidity premium and that the bank can provide actuarially fair liquidity insurance through credit lines. However, we note that this implication would continue to hold if we had introduced liquidity premia and costly credit line provision in the model. The key point to note is that these costs are independent of the liquidity risk mechanism. For example, having a positive liquidity premium would make it less likely that a firm would use cash (for a given amount of liquidity risk), but does not change the comparative statics on liquidity risk itself.

natural determinant of firm's liquidity risk is the variability in firm cash flows. Firms with greater cash flow variance face a higher risk of facing liquidity shortfalls. This line of reasoning suggests the following implication:

1.1 *Firms with low cash flow risk are more likely to use credit lines rather than cash for liquidity management, when compared to firms with high liquidity risk.*

In addition, the model also relates liquidity risk to pledgeable income. For a given level of cash flow risk, firms that have higher pledgeable income face a lower risk of facing future liquidity shortfalls. Thus, the model also delivers the following implication:

1.2 *Firms with high pledgeable income are more likely to use credit lines rather than cash for liquidity management, when compared to firms with low pledgeable income.*

Pledgeable income is a direct function of the firm's ability to raise external funds. Credit ratings should capture heterogeneity in pledgeable income, to the extent that they capture the ease of accessing public bond markets. The model would thus predict that rated firms should be more likely to use credit lines than non-rated firms, and firms with high credit ratings should be more likely to use credit lines than firms with low credit ratings. An alternative proxy for pledgeable income is the tangibility of firm's assets. Firms with more tangible assets should be more likely to use credit lines for liquidity management. Finally, one may argue that firm size is correlated with pledgeable income. Larger firms are more transparent and have easier access to external finance.

These implications are broadly consistent with other results reported in the literature. The standard approach in the existing empirical literature is to examine the cross-sectional association between firm-level variables (such as cash flow risk, credit ratings and tangibility) and corporate liquidity policy.[20]

Nevertheless, these existing tests suffer from the usual limitations associated with cross-sectional regressions. Unobservable firm-level variation can make it difficult to interpret the coefficients on standard proxies for liquidity risk. For example, some firms may not have access to bank-provided insurance due to lack of reputation and track record. These firms are also likely to have lower credit ratings and to be riskier than other firms. In this case, a negative correlation between liquidity risk proxies and credit line usage cannot be interpreted as evidence that liquidity risk causes firms to switch to cash holdings. Reverse causality is

[20] Standard datasets that contain information on credit lines are typically short in the time dimension. For example, Sufi's (2009) data encompasses the period of 1996 to 2003. Thus, most of the variation driving existing results in the literature is cross-sectional.

also a possibility. To wit, firms may have high credit ratings *because* they have access to credit line insurance.

In order to provide evidence that liquidity risk causes firms to switch from credit lines to cash-based liquidity insurance, one would like to trace the effects of a shock that *changes* the liquidity risk (but not other fundamentals) of a group of firms, while leaving other firms unaffected. It is very difficult to think of a shock that changes cash flow risk without affecting other fundamentals such as the productivity of investment. Shocks that affect the ability of a group of firms to raise external funds, while arguably leaving fundamentals unaffected, provide a more suitable setting for a test of Implication 1.

We propose two identification strategies, which we discuss further in Section 4.3. We first rely on a quasi-natural experiment and examine the evolution of liquidity ratios during the downgrade to junk status of General Motors Corp. (GM) and Ford Motor Co. (Ford) that occurred in the spring of 2005. Due to their importance as issuers in the public bond market, the downgrade had an impact on the liquidity of the bond market as a whole. Firms that depended on bond financing and needed financing became suddenly exposed to the effects of the downgrade, and found it more difficult to raise debt in the form of bonds. Notably, the firms that were most affected by this shock were well-established, mature firms that have good access to bank financing. And for many of these firms (notably those outside of the auto sector), fundamentals were likely not affected by the bond market shock. In this sense, evidence that bond-reliant firms switch from credit lines to cash in the aftermath of the GM-Ford crisis is consistent with the hypothesis that changes in liquidity risk causes firms to change their liquidity policy.[21]Second, we examine the effect that the price pressure associated with mutual fund redemptions has on liquidity ratios. Our hypothesis is that firms whose equity is subject to downward price pressure may face a higher cost of issuing equity, and that this lower ability to raise equity decreases firms' pledgeable income and increases their liquidity risk.[22]

The second set of empirical implications of the model relates to the relationship between credit lines, hedging needs, covenants and revocations. Our Proposition 5 states that firms with low hedging needs are more likely to use credit lines for liquidity management, when compared to firms with high hedging needs. An empirical proxy for the firm's hedging needs is the correlation between cash flows and investment opportunities (as in Acharya, Almeida and Campello (2007)). The following empirical prediction stems from the model:

[21]Deadweight costs of credit line provision by banks (which are absent from the model) could have amplified this effect, because banks themselves faced greater costs of borrowing from the bond market in the aftermath of the GM-Ford crisis.

[22]We thank our referee for suggesting this alternative identification strategy.

2. *Firms with a high correlation between cash flows and investment opportunities (low hedging-needs firms) should be more likely to use credit lines rather than cash for liquidity management, when compared to firms with a low correlation (high hedging-needs firms).*

Our model also has predictions for the relationship between hedging needs and covenants in credit line contracts. As we discuss in Section 2.4.4, the presence of a future investment opportunity may provide incentives for firms to avoid illiquidity transformation independently of monitoring, and these incentives are stronger for firms whose investment opportunities tend to arrive in high cash flow states (low hedging-needs firms). Because of this differential incentive effect, we have:

3. *Credit lines for low hedging-needs firms are less likely to contain covenants than credit lines for high hedging-needs firms:*

Because low-hedging needs firms can access credit lines that contain less contractual restrictions, we should have that:

4. *Low hedging-needs firms are less likely to face revocation of bank credit lines than high hedging-needs firms.*

We also use our data to track down the following predictions about other characteristics of the monitoring mechanism which according to the theory is behind the empirical relationship between liquidity risk and liquidity management:

5. *Credit line contracts contain covenants contingent on firm profitability, and access to credit lines is sometimes restricted when firm profitability decreases.*

In the model, this pattern is part of an optimal liquidity management policy that discourages credit line users from engaging in illiquidity transformation. In particular, the model explains why credit line revocation is concentrated in states in which the firm reports negative profitability shocks. Such shocks increase the demand for credit line insurance, and thus the bank's incentives to monitor in order to avoid credit line drawdowns by the firm.

Existing evidence on the frequency of credit line revocations is mixed. Some papers report significant revocation following covenant violations that are triggered by declines in profitability (e.g., Sufi, 2009), while other papers argue that revocations are infrequent (Barakova and Parthasarathy, 2012, Berrospide, Meisenzahl, and Sullivan, 2012). We use the Capital IQ data to provide additional large sample evidence on the frequency and magnitude of revocations.

The revocability of credit line access is not incompatible with credit lines' role as liquidity insurance. If revocation does not occur, a firm facing a liquidity shock may draw down on the credit line to meet the shortage of liquidity:

6. *Credit line drawdowns are more likely to happen following decreases in firm profitability.*

Thus, both drawdowns and revocations should be more likely in low profitability states. In addition, if credit line users have low liquidity risk when compared to firms that employ cash, the following implication should also hold:

7. *Credit line drawdowns are relatively infrequent, so that credit line drawdowns to meet liquidity needs are significantly less frequent that reductions in cash holdings to meet liquidity needs.*

The *ex-post* usage of credit lines and cash to meet liquidity needs should be consistent with *ex-ante* differences in liquidity risk exposure across firms. We use our data to verify whether these predicted patterns are consistent with data on real world credit lines.

4 Empirical tests

In this section we present our empirical analysis.

4.1 Sample Construction and Description

We obtain firm-level data from the Capital IQ (CIQ) and Compustat databases for the period of 2002-2011. We restrict ourselves to U.S. firms covered on both databases and traded on AMEX, NASDAQ, or NYSE. We remove utilities (SIC codes 4900-4999) and financial firms (SIC codes 6000-6999). Following Bates, Kahle and Stulz (2009), we further remove firm-years with negative revenues, and negative or missing assets, obtaining in the end a sample of 32,671 firm-years involving 4,741 unique firms.

CIQ compiles detailed information on capital structure and debt structure by going through financial footnotes contained in firms' 10-K Securities and Exchange Commission (SEC) filings. Most importantly for our purposes, firms provide detailed information on the drawn and undrawn portions of their lines of credit in the liquidity and capital resources section under the management discussion, or in the financial footnotes explaining debt obligations, and CIQ compiles this data. We use the information of CIQ to construct a dummy for the presence of a credit line, which is equal to one if the firm has a positive amount of undrawn credit reported in the 10-K. Following Sufi (2009) we also construct a measure of the amount of undrawn credit expressed as a percentage of net book assets. Following Lemmon, Roberts and Zender (2008), we compute a set of firm characteristics such as profitability, market-to-book (M/B) and tangibility. We also compute firm–year rating as the average monthly rating by S&P (item 280), after converting the S&P rating into numbers. Credit spread is the spread on U.S. corporate bond yields between Moody's AAA and BAA provided by Datastream, based on averages of seasoned issues. We compute the firm's asset (unlevered) beta, calculated from equity (levered) betas and a Merton-KMV formula as in Acharya, Almeida and Campello (2012). Finally, following standard procedures, all variables are winsorized at the 0.5% level in both tails of the distribution. See the appendix for a complete set of definitions.

4.2 Descriptive Statistics

Table 1 provides univariate evidence on the differences in firm characteristics across the samples of firms with and without a line of credit. In column 1 we report mean and median values for the entire sample, while column 2 and 3 contain values for the sub-samples of firms with and without a line of credit, respectively.

Table 1 allows for a broad comparison of firms with and without a line of credit. The main picture that emerges from the table is that the sample of firms with a line of credit is significantly different from the rest along all the dimensions reported in the table. Firms with a line of credit are more profitable, more leveraged, are more likely to pay dividends, have lower beta, and are more likely to be rated. These firms also invest more in working capital and capex, but have lower R&D expenses. Overall, these characteristics suggest that firms with a line of credit are more established, mature firms with fewer growth opportunities and more stable cash flows. Table 1 is also informative on the relative sizes of lines of credit and cash across the two samples. Focusing on firms with a line of credit, column 2 shows that average cash holdings are larger than average credit lines, both as a percentage of net book value assets (35% versus 15.6%). However, the magnitude of the ratio for cash and credit lines is similar if we divide by the market value of assets, respectively 9.3% and 9.6%.

TABLE 1 ABOUT HERE

Several of our model's predictions are consistent with this univariate evidence. Firms that use credit lines for liquidity management have more tangible assets, and higher credit ratings than those that use cash for liquidity management. This evidence is also in line with that reported in previous literature.[23]

Figure 2 illustrates the distribution of profitability and cash flows over assets for firms with and without a line of credit (*LC firms* and *cash firms*, respectively). The figure shows that firms that use cash have a higher probability of having low profitability and low cash flows than firms that use credit lines.

FIGURE 2 ABOUT HERE

4.3 Implication 1: Liquidity risk and liquidity management

Our model predicts that an increase in liquidity risk should cause firms to switch from credit lines to cash in their liquidity management. We test this implication in this Section using two alternative identification strategies.

4.3.1 The GM-Ford Downgrade

In May 2005 Standard and Poor's downgraded the ratings of bonds issued by GM and GMAC, its financial arm, from BBB- to BB, two notches below investment grade. Similarly, Ford and FMCC, its financial subsidiary, had their rating reduced from BBB- to BB+, one notch below investment grade. According to Acharya, Schaefer and Zhang (2008), the downgrade led to a market-wide sell-off of the corporate bonds issued by these two firms. It also had a significant impact on inventory risk faced by financial intermediaries that operated as market makers for the securities issued by the two auto makers. The effect of the downgrade went beyond the bond markets of GM and Ford and of other producers in the auto sector, and was perceived at the time to be potentially long-lasting. Because of their size and their importance in the debt markets, the credit deterioration of the two giant auto makers affected the functioning of corporate-bond markets as a whole. Acharya, Schaefer and Zhang document that simultaneously with the downgrade, there was excess comovement in the fixed-income securities of all industries, not just in those of auto firms.

In an article that appeared on May 12th, 2005 *The Economist* observes that "*...the most obvious instances of this [rising interest rates on American companies' bonds] have been the bonds of two giant carmakers, General Motors and Ford, which Standard & Poor's (S&P), a rating agency, downgraded to junk status on May 5th. However, the malaise in the market for corporate debt goes far wider than these two big names....Several planned bond issues have been*

[23] In Table A1 in the appendix, we provide multivariate evidence on the relationship between credit line usage and firm characteristics. The patterns that we uncover using Capital IQ data are very similar to those reported in existing literature.

postponed because investors are becoming more demanding. Plenty of companies besides GM and Ford have been marked down." All of this happened in the context of a booming economy, and the same article comments that "*By many measures, America's economy continues in strikingly good health*". The last statement suggests that the effect of the GM-Ford downgrade was a shock primarily to the corporate bond market rather than to the economy at large.

The downgrade of GM-Ford offers an opportunity to identify the effects of liquidity risk on liquidity policy. Our empirical strategy is to examine whether firms that faced a larger increase in liquidity risk (firms who are heavily financed by publicly-traded bonds, the *treatment* group) increased their cash holdings, as a share of total liquidity, more than the rest of the firms (*control* group). In normal times, bond-dependent firms are less likely to be exposed to liquidity risk because they tend to be less financially constrained and more profitable. However, the key identification assumption for our tests is that the GM-Ford shock *increases* liquidity risk for bond-dependent firms, more so than for firms that do not rely as much on bond markets for their financing.

The other key assumption behind our identification strategy is that there are no unobservable variables that explain both a firm's reliance on bonds (which is endogenously determined), as well as its sensitivity to the GM-Ford shock. This is the "exclusion restriction" for our test. As a first step towards ensuring that our exclusion restriction holds, we sort firms according to the average exposure to bond financing measured at the industry-level. This sorting eliminates the possibility that a firm-level unobserved characteristic that varies within industries could explain the results.[24] Specifically, to identify the treatment firms, we construct three sorting variables: i) the ratio of a firm's outstanding bonds over the book value of its assets; ii) a dummy for firms with outstanding bonds greater than 50 percent of debt; iii) a dummy for being rated. In our main specification, the crisis period lasts from December 2004 to May 2005.[25] Accordingly, for each of these variables we compute the industry average in fiscal year 2003 at the three-digit SIC code, and their average over the whole sample in the years 2003 and 2004. All the firms whose industry has an average higher than the sample average are identified as belonging to the *treatment* group. For example, if an industry has a higher percentage of rated firms in 2003 than the sample average, all firms in the industry belong to

[24] Measuring bond reliance at the industry-level does not alleviate all endogeneity concerns, because the unobservable characteristic that explains both bond reliance and the sensitivity to GM-Ford could be correlated across firms in the same 3-digit SIC industry. We provide additional support for our identification strategy below.

[25] The crisis began with the downgrade of GM and GMAC by S&P and Moody's in October 2004. In March 2005 GM issued a profit warning, and was subsequently downgraded by Fitch and Moody's. In April 2005 Ford issued a profit warning which subsequently led to its downgrade by all three rating agencies. In May 2005 both automakers were excluded from Merrill's and Lehman's investment-grade indices. See Acharya, Schaefer and Zhang (2008) for a detailed timetable of the events.

the treatment group for both fiscal years 2003 and 2004.

We conduct a difference-in-difference analysis in a regression framework. For all observations that occur during the crisis period the variable $crisis_{i,t}$ takes the value of 1, and 0 otherwise. We exclude from the analysis all firms with a rating below B- as they are too close to default. To focus only on a "pure" liquidity risk event, and to exclude possible supply effects, we drop all firm-years for which reporting occurred after May 2005. In other words, we include only firm-years for which reporting occurred during any month of the fiscal years 2002-2004 (according to Compustat May 2005 belongs to fiscal year 2004). Finally, we require all firms to have data for every period in fiscal years 2003-2005.

Since this is a difference-in-differences (DID) empirical design, time-invariant variables (even unobservable ones) are differenced out and do not compromise identification. We further verify our identification assumptions by conducting a placebo test that shows that the differential change in liquidity management across bond-reliant and other firms obtains only in the aftermath of GM-Ford. The *placebo crisis* is defined as the period that goes from December 2003 to May 2004. For this exercise, we classify firms as being in the treatment group depending on whether they were rated in fiscal year 2002. This placebo test helps narrow down the set of possible alternative explanations for the results. If the results only obtains following GM-Ford, any alternative explanation must also predict a shift towards cash for bond-dependent firms that happens only in the treatment period, not in other periods.

Table 2 illustrates the results of our analysis of the GM-Ford crisis period. Our base specification is provided in column 1 as follows:

$$\begin{aligned}\left(\frac{cash}{cash + undrawn}\right)_{i,t} &= \alpha_0 + \alpha_1 crisis_{i,t} + \alpha_2 treatment_i + \alpha_3 (crisis_{i,t} * treatment_i) \\ &\quad + firm\ controls_{i,t} + industry\ mean_{i,t} + \varepsilon_{i,t}\end{aligned}$$

The coefficient of interest is α_3, which captures the estimate of the difference-in-difference. We expect treatment firms to be more exposed to the liquidity effects of the GM-Ford downgrade. Therefore, α_3 should be positive in column 1 across Panels A-C.

TABLE 2 ABOUT HERE

Column 1 Panel A shows that treatment firms had on average around 7.4% less cash as a share of total liquidity relative to control firms before the crisis (α_2).[26] During the crisis control firms decreased their cash by 1.9% (α_1), and treatment firms reduced their cash by 3.2% less than control firms. Therefore, the difference in cash holdings between the two groups

[26] This difference may reflect the lower liquidity risk of bond-dependent firms.

decreased in absolute terms to approximately 4% during the crisis ($\alpha_3 - \alpha_2$). These findings are confirmed for the other sortings reported in column 1 of Panels B and C. Overall these results are in line with our prediction that bond dependent firms shifted from lines of credit to cash as a result of an increase in liquidity risk.

In columns 2-4 we examine which margins were at work during the GM-Ford crisis, by looking at the behavior of cash, undrawn credit lines, and the sum of cash plus undrawn credit lines, all computed as a percentage of net assets. We find that while cash holdings decreased around 2% on average in the control group during the crisis, they remained essentially unchanged for treatment firms ($\alpha_3 - \alpha_1$). This evidence is consistent with our interpretation of the GM-Ford event as a rise in future liquidity risk rather than as a current liquidity shock. Under the liquidity shock interpretation, treatment firms would have been expected to decrease their cash as a percentage of assets during the crisis period.

In column 3 we find that undrawn credit lines did not vary for the control group, while they decreased by around 1% as a percentage of assets during the crisis for the treated group. The drop in credit lines for treatment firms may indicate that they drew down on their outstanding credit lines, or opened less or smaller credit lines, both possibly as a result of increased liquidity risk, and both consistent with our theoretical predictions. It could also mean, however, that treatment firms faced a restriction in access to credit lines during the GM-Ford event that did not affect control firms as much. While this mechanism is not inconsistent with our model, it suggests that the downgrade affected the liquidity of banks, who reacted by revoking their outstanding credit lines. Likely, revocations occurred at a faster rate for treated firms because their liquidity position had deteriorated more. Alternatively, treatment firms may have violated some of the covenants associated with their credit lines, and these violations may have led to a revocation of the line.[27] Finally, column 4 shows that overall liquidity dropped for all firms during the crisis, but relatively less for treatment firms (Panel C).

The analysis of a placebo crisis is reported in Table 3. It shows that all firms had lower cash holdings during the proposed placebo crisis, and treatment firms did not behave differently from control firms. These results support our identification assumptions.[28]

[27] In unreported analysis we find that treatment firms were not exposed to an increase in revocations of credit lines during the crisis months relative to control firms, and that treatment firms did not suffer an increase in covenant violations relative to control firms. This evidence suggests that bank credit line revocations were not behind the decrease in undrawn credit experienced by treatment firms in the aftermath of the GM-Ford downgrade.

[28] In Table A2 of the appendix we examine whether we can find evidence of changes in liquidity policy following changes in market conditions. A natural hypothesis is that the results should be symmetric, that is, bond-dependent firms should increase their reliance on credit lines in periods of hot bond markets. We find

Table 3 About Here

The results above show that bond-dependent firms shifted from credit lines to cash in the aftermath of the GM-Ford shock.[29] Does this result simply reflect a shift from external to internal finance engendered by an increase in the cost of external finance? In order to address this concern, we perform two complementary tests.

First, in Table 4 we examine how cash was raised during the GM-FORD crisis. In Panel A the table relates the change in cash holdings to the main components of the cash flow statement, both during the GM-FORD event and outside the event. The results show that some of the channels that operate in normal times were shut down during the crisis in the subset of bond dependent firms, in particular debt issues. At the same time, however, equity issues remained an active source of cash during the crisis for bond dependent firms. These results suggest that firms that typically rely on bonds were forced to rely more on equity issuance to raise cash during the GM-Ford crisis period. These results also suggest that bond-reliant firms were not cut off from all sources of external financing in the aftermath of GM-Ford, and could use equity issuances to raise cash. This flexibility may be due to the fact that bond-reliant firms are relatively less financially constrained than an average firm.

Table 4 About Here

In Panel B, we relate changes in undrawn credit to drawdowns, controlling for a set of firm characteristics. The relationship between drawdowns and changes in undrawn credit became stronger during the crisis, suggesting that firms used their existing lines of credit possibly to increase their cash holdings.

Second, in Table A4 in the appendix we sort firms according to their external finance dependence, computed as in Rajan and Zingales (2005). If the effects of GM-Ford simply reflect a substitution of external for internal finance, then we might expect externally dependent firms to be affected more than the rest of the firms. On the contrary, we find that during the crisis more externally dependent firms decreased their cash ratios as a percentage of total liquidity and as a percentage of assets, and increased their exposure to credit lines. This evidence suggests that the GM-Ford event was not a widespread shock to externally dependent firms, but rather a specific shock to bond dependent firms.

evidence consistent with this hypothesis. The results must be interpreted with caution because changes in market conditions are associated with changes in firm fundamentals.

[29] Table A3 provides some evidence that in 2005 there was a partial reversal of the reported effects on cash for treatment firms. Specifically, rated firms decreased their reliance on cash holdings during 2005.

4.3.2 Mutual Fund Redemptions

Our interpretation of the evidence above relies on a key exclusion restriction: there are no unobservable variables that explain both a firm's reliance on bonds and also its sensitivity to the GM-Ford shock. Since bond dependence is endogenously determined, we cannot entirely rule out this possibility. Thus, in order to provide additional evidence for the causal effect of liquidity risk on liquidity management, we complement the GM-Ford test with an alternative identification strategy. This alternative strategy relies on the hypothesis that firms whose equity is subject to downward price pressure may face refinancing problems. Insofar as a firm has refinancing needs that are to be met by issuing equity, price pressure increases liquidity risk.

Following Edmans, Goldstein and Jiang (2012), we collect data on mutual fund redemptions and use them to construct a measure of price pressure for the firms in our sample. We compute fund flows $MFFlow$ as the sale of a firm's equity as a percentage of its dollar trading volume, associated with mutual fund outflows greater than 5%.[30] The main argument for using this measure of price pressure is that it is associated with mutual fund trading due to investor flows rather than to firm fundamentals. Thus, such price pressure should affect liquidity policy only through its effects on equity mispricing. Furthermore, the advantage of using equity price pressure is that it is not directly related to debt financing and can therefore be more exogenous when examining changes in firm demand for credit lines.

Our main evidence on fund redemptions is reported in Table 5. We construct two measures of outflow: i) a dummy equal to one if the firm has been subject to an outflow; ii) a continuous measure $Outflow$ defined as the absolute value of $MFFlow$. We run a set of regressions in which our measures of liquidity management are related to the two measures of outflows across the whole sample (Panels A and B) and for the subsample of firms for which an outflow occurred (Panel C). In all regressions we control for a large set of firm characteristics. The main result of the table is to show that there is an effect of outflows on liquidity management: as downward price pressure increases, firms shift to cash holdings in their liquidity management (column 1).

<u>TABLE 5 ABOUT HERE</u>

One important difference between the results of Table 5 and those following the GM-Ford shock is that firm cash holdings and total liquidity tend to *decrease* following mutual fund outflows (columns 2 and 4), while both cash and total liquidity increased for bond-dependent

[30] See Appendix A of Edmans, Goldstein and Jiang (2012) for a detailed description of how $MFFLow$ is constructed.

firms following GM-Ford. This decrease in cash is probably due to the fact that firms that face downward price pressure due to outflows are forced to use up some of their cash to finance operations.[31] Still, their usage of credit lines decreases even more (column 3), generating the increase in the ratio of cash to total liquidity documented in column 1. Thus, firms rely more on cash for their liquidity management following a shock to their ability to raise equity. These results provide further support to the empirical implications of our model.

4.4 Liquidity management and hedging needs

In this section we test the predictions of the model regarding the relationship between hedging needs and a firm's liquidity policy. We build on Acharya, Almeida and Campello (2007) and Disatnik, Duchin and Sensoy (2010) to construct proxies for hedgustry annual cash flow at the three-digit SIC code. Similarly we compute the mean industry annual investment activities (Hedging Investment Activities), and mean industry annual market-to-book ratio (Hedgining needs at the industry level.

More precisely we first compute the mean indg Tobin's Q). We then compute the correlation between cash flows and, respectively, investment activities and market-to-book. We use industry-level variables to mitigate the possibility that cash flows are endogenously related with investment and therefore with Tobin's Q. To further address this issue, we calculate industry-level investment opportunities using only data for financially unconstrained firms. Firms are defined to be financially unconstrained if they pay dividends, have assets above $500m and rating above B+.

4.4.1 Implication 2: Hedging needs and the use of lines of credit

We first test the empirical prediction that *low hedging needs* firms are more likely to use lines of credit instead of cash for liquidity management, when compared to *high hedging needs* firms. Table 6 compares several measures of liquidity policy by sorting firms into high and low hedging needs categories. High (low) hedging needs firms are those with a correlation in the bottom (top) quintile.[32] The table displays the differences in the presence of a line of credit, the amount of undrawn credit as a share of net assets, the share of undrawn credit in total liquidity, and total revolving credit over net assets. In Panel A we calculate the raw statistics for the four liquidity variables across the sample of high and low hedging needs firms. In Panel B we relate hedging needs with the residuals obtained from regressions in which we

[31] Bond-dependent firms have higher credit quality than an average firm, and thus may be shielded from the need to use up cash to finance operations following GM-Ford.

[32] We report other cutoffs in Table A6 in the appendix.

control for a set of firm characteristics. By looking at regression residuals, rather than at the raw variables, we can evaluate the relationship between hedging needs and our four liquidity variables after controlling for firm characteristics.

Table 6 About Here

The evidence of Table 6 is consistent with the prediction of the model. Using the measure of hedging needs based on industry median investment activities, Panel A shows that the percentage of firms with a credit line is 81.8% among firms with low hedging needs, while it is only 54.0% for firms with high hedging needs. Low hedging needs firms have more undrawn credit both as a percentage of assets (12.6%) and as a percentage of total liquidity (53.6%), than high hedging needs firms (respectively 7.9% and 23.3%). Low hedging needs firm also have a higher percentage of revolving credit as a percentage of net assets (5.0%) than high hedging needs firms (2.3%). Panel B confirms the results provided in Panel A, using regression residuals.

4.4.2 Implication 3: Hedging needs and the use of covenants

Table 7 estimates the relationship between the covenants attached to credit lines and hedging needs. We obtain data on covenants from LPC Dealscan and examine all the covenants on credit lines for the firms in our sample during the period 2002-2008. In most cases, firms are granted several new credit line facilities in the same year. For these cases we report the median number of covenants across facilities.

We use four measures of covenant intensity. The first measure of covenant intensity is based on the covenant index of Drucker and Puri (2009) which is computed as the sum of all the covenants included in a loan agreement. Our second measure is borrowed from Demiroglu and James (2010), and it is itself based on the covenant intensity index originally introduced by Bradley and Roberts (2004). This index consists of covenants that limit the actions of the borrower, or give lenders rights that are contingent on adverse future events. The index is composed of six types of covenants: asset sales sweeps, collateral releases, debt issuance sweeps, dividend restrictions, a dummy for financial covenants, and equity issuance sweeps. Our third measure of covenant intensity focuses on the covenants that relate directly to cash flows. These covenants primarily require minimum profitability levels, minimum interest coverage ratios, and restrictions on cash flow usage. Our fourth measure of covenant intensity is based on the presence of *sweeps*, such as asset sale sweeps, debt issuance sweeps, and excess cash-flow sweeps. These covenants impose restrictions to managers' payout and reinvestment policy, giving preference to debt reimbursement over other possible uses of cash flows.

Table 7 About Here

We run a set of Poisson regressions using our four covenant intensity measures as dependent variables. Among the explanatory variables, the variables of main interest are the two hedging measures already employed in Table 6, the first one based on investment activities and the second one on Tobin's Q. We also control for a set of variables identified by Demiroglu and James (2010) as relevant for the use of covenants.

According to our model, we should expect a positive relationship between the intensity of covenants and hedging needs, meaning that credit lines for low hedging needs firms tend to carry fewer covenants. The evidence provided in Table 7 suggests that this is the case, as covenants are less prevalent for firms that have high correlation between cash flows and investment opportunities (low hedging needs firms). Focusing on the covenant intensity measure most relevant to the type of bank monitoring described in our model, the cash flow covenant index, column 5 shows that, for the hedging needs measure based on investment activities, an increase by two standard deviations in the hedging variable (0.751), i.e. an increase in correlation between cash flows and investment opportunities, is associated on average with having 14.4% ($= 1 - e^{-0.208 \times 0.751}$) less covenants, holding the other variables in the model constant.

4.4.3 Implication 4: Hedging needs and credit line revocations

To test the implication that low hedging-needs firms are less likely to face revocation of credit lines, we limit the sample to firms that have undrawn credit available under a credit line in period $t - 1$, and study whether access to the line of credit is restricted during period t. We consider a full 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 amount of drawn credit has not increased between the two periods. For robustness, we also consider partial revocations by examining losses of at least 50% of undrawn credit over one year.[33] At the univariate level, the annual frequency of revocations is 4.1% and that of a reduction in credit lines greater than 50% is 7.9%. In the subsample of firms with negative profits, these percentages are respectively 15.3% and 23.5%.[34]

[33] As firms typically hold lines of credit with more than one bank, our measure of partial revocations may capture full revocations of individual lines.

[34] Both our measures of revocations, full and partial, might overestimate true revocations because they treat voluntary non-renovations of credit lines as revocations. However, two reasons suggest that this overestimation might be small, particularly for full revocations. First, undrawn credit lines are not very expensive; annual fees on the undrawn portions of credit lines are around 25 basis points on average (Sufi (2009)). Second, firms may be unwilling to lose their credit lines as it may send a negative signal to investors.

TABLE 8 ABOUT HERE

Table 8 provides evidence on the relationship between revocations of credit lines and hedging needs, controlling for a set of key firm characteristics. The evidence reported is consistent with our theory. Column 1 shows that an increase by two standard deviations (0.751) in the hedging variable based on investing activities, i.e. a decrease in hedging needs, is associated on average with a decrease of 0.7% ($= -0.009 \times 0.751$) in the probability of facing a revocation, holding other variables constant. This effect is similar for the hedging needs measure based Tobin's Q (column 2). The evidence for partial revocations is less strong, suggesting that the effect of hedging needs on the probability of revocations is mainly associated with full revocations.

4.4.4 Implications 5-7: Profitability, revocations and drawdowns

With respect to the relationship between profitability and revocations, columns 1-4 of Table 8 shows that access to undrawn credit depends positively on profitability.[35] A two standard deviations increase in profitability (0.432) is associated with an decrease of 2.2% ($= -0.051 \times 0.432$) in the probability of facing a full revocation (column 1), and a 4.9% ($= -0.113 \times 0.432$) decrease in the probability of facing a revocation of at least 50% of undrawn credit (column 3).

Table 8 also provides evidence on the relationship between credit line drawdowns and profitability. The evidence above on the revocability of credit line access is not incompatible with credit lines' role as liquidity insurance and if revocation does not occur, a firm facing a liquidity shock may draw down on the credit line to meet the shortage of liquidity. To see if this is the case, in columns 5 and 6 of Table 8, we regress the annual variation in revolving credit on profitability. The regression shows a negative and significant relationship between profitability and variations in total drawn lines of credit, as predicted by our model. This evidence shows that an increase in revolving credit is associated with a drop in profitability, and it suggests that credit lines are employed by firms to withstand liquidity shocks resulting from a shortfall in cash flows.[36]

[35] For each regression specification we provide several different definitions of profitability: the standard definition of profitability computed as operating income before depreciation, scaled by assets; a dummy for profitability being positive; a dummy for profitability being above 5%; the change in profitability, measured as the difference between profitability in year t minus profitability in year $t-1$; and one variable for the positive changes in profitability *(increases in profitability)* and one for the negative changes (*decreases in profitability*). Results (unreported) are qualitatively unaffected for these other measures of profitability.

[36] For robustness, we also run unreported tests in which we restrict variations in revolving credit to be positive. In this way, we can better isolate the variations in revolving credit that arise from a drawdown, from

Implication 7 says that firms that use credit lines for liquidity management should be less likely to draw on credit lines to meet liquidity needs, when compared to firms that rely on cash holdings. We first test this prediction by comparing the frequency of low profit realizations for firms with and without a credit line. In particular, we compare the frequency of profitability being below 0% and 5%. The evidence, reported in Panel A of Table 9, shows that on average credit line users are significantly less likely to face a negative or low profitability shock.

TABLE 9 ABOUT HERE

Next, we examine the probability that firms with and without credit lines use their liquidity to meet a shortfall in cash flows. For this purpose, we construct a new variable which is a dummy that takes the value of one when a drawdown occurs during a period in which profitability is negative. We then calculate the frequency of this event (liquidity event) in the sample of firms with a line of credit. To compare this with firms that do not use credit lines, we calculate a similar variable for cash drawdowns, and compare both frequencies. The evidence is reported in Panel B of Table 9. In line with the empirical prediction of the model, liquidity events associated with drawdowns of credit lines are significantly less frequent than liquidity events associated with reductions in cash holdings.

5 Conclusions

Recent empirical evidence on corporate liquidity management suggests that bank credit lines do not offer fully committed liquidity insurance, and that they are used not only for precautionary motives, but also to finance future growth opportunities. In this paper, we propose and test a theory of corporate liquidity management that is consistent with these findings. We argue that a corporate credit line can be understood as a form of monitored liquidity insurance, which controls illiquidity-seeking behavior by firms through bank monitoring and credit line revocation. In addition, we allow firms to demand liquidity not only to hedge against negative profitability shocks, but to help finance future growth opportunities. We show that bank monitoring is more costly for firms that have greater arrival of growth opportunities in states in which cash flows are low (high hedging-needs firms). Such firms find it more beneficial to move to cash holdings, in order to avoid revocation costs associated with credit lines.

the variations that arise from repayments. We also run a specification in which the dependent variable takes value zero if the change in revolving credit is non-positive. The results obtained in these additional regressions confirm the above results.

We use a novel dataset on corporate credit lines to provide empirical evidence that is consistent with the predictions of the model. The evidence suggests that credit line users have lower liquidity risk than firms that use cash for liquidity management. The causality from liquidity risk to liquidity management is supported by two alternative tests that both show that firms that were more exposed to a liquidity shock moved away from credit lines into cash holdings. In addition, we also find evidence that firms with high hedging needs are more likely to use cash rather than credit lines for liquidity management. These firms also face more covenants and credit line revocations when they do use credit lines, when compared to firms with low hedging needs.

There are several interesting avenues for shedding further light on the relationship between illiquidity transformation and bank monitoring. One is the empirical relationship between the ex-post reported purpose of line of credit draw-downs and the presence of covenants. Credit lines designated and primarily used for activities with low illiquidity-seeking risk, such as working capital management, may reflect fewer features of monitored insurance than credit lines used for activities with high illiquidity-seeking risk, such as mergers and acquisitions. Another avenue is to study carefully the aftermath of a covenant violation for a firm's line of credit, and in particular, the factors that determine whether covenants are waived by banks providing the credit line or whether they instead generate credit revocations. Finally, material adverse clauses (MACs) are another way through which banks may employ their monitoring information. While invoked infrequently, the off-equilibrium threat of MACs could have significant impact on firm incentives to engage in illiquidity-seeking activities.

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6 Appendix

In this theoretical appendix we provide proofs and develop some of the arguments in the main body of the paper in greater detail.

6.1 Moral hazard and pledgeability

In order to see how moral hazard generates limited pledgeability, consider the following set up. If the firm continues until date-2, the investment produces a date-2 cash flow $\widehat{R}$ which obtains with probability p. With probability $1-p$, the investment produces nothing. The probability of success depends on the input of specific human capital by the firms' managers. If the managers exert high effort, the probability of success is equal to p_G. Otherwise, the probability is p_B, but the managers consume a private benefit equal to $\widehat{B}$. While the cash flow $\widehat{R}$ is verifiable, the managerial effort and the private benefit are neither verifiable nor contractible. Because of the moral hazard due to this private benefit, managers must keep a high enough stake in the project to be induced to exert effort. We assume that the investment is negative NPV if the managers do not exert effort, implying the following incentive constraint:

$$\begin{aligned} p_G\widehat{R}_M &\geq p_B\widehat{R}_M+\widehat{B}, \text{ or} \\ \widehat{R}_M &\geq \frac{\widehat{B}}{\Delta p}, \end{aligned} \tag{18}$$

where $\widehat{R}_M$ is the managers' compensation and $\Delta p = p_G - p_B$. This moral hazard problem implies that the firms' cash flows cannot be pledged in their entirety to outside investors. In particular, we have that:

$$\widehat{\rho_0} \equiv p_G(\widehat{R}-\frac{\widehat{B}}{\Delta p}) < \widehat{\rho_1} \equiv p_G\widehat{R}. \tag{19}$$

The manager's choice of $\widehat{\lambda}$ impacts the project's cash flows and private benefits in the following way. If the manager chooses the illiquid project ($\widehat{\lambda}=\lambda^{'}$), we have that $\widehat{R}=R^{'}$ and $\widehat{B}=B^{'}$. If the manager chooses the liquid project ($\widehat{\lambda}=\lambda$), we have that $\widehat{R}=R$ and $\widehat{B}=B$. Finally, we have that $R^{'}>R$ and $B^{'}>B$. Thus, the illiquid project produces a higher cash flow when it is successful, and a higher associated private benefit. We make the following assumption:

$$\rho_0^{'} \equiv p_G(R^{'}-\frac{B^{'}}{\Delta p}) = \rho_0 \equiv p_G(R-\frac{B}{\Delta p}). \tag{20}$$

Thus, $\widehat{R}$ and $\widehat{B}$ change in a way that leaves ρ_0 constant.

6.2 Proof of proposition 1

Suppose the firm chooses the liquid project, and promises a payment D to the bank. Let us first show when fully committed liquidity insurance is feasible.

Sticking to the liquid investment produces a payoff for the firm equal to:

$$(1-\lambda)(\rho_1+\upsilon^H\rho^\tau-D)+\lambda(\rho_1+\upsilon^L\rho^\tau-D)=\rho_1-D+\overline{\upsilon}\rho^\tau. \tag{21}$$

That is, the firm uses the credit line to continue the project and fund the new investment, and repays D to the bank in both states. If the firm deviates and shifts funds into the illiquid project, the payoff is:

$$(1-\lambda^{'})(\rho_1^{'}+\upsilon^H\rho^{\tau}-D)+\lambda^{'}(\rho_1^{'}+\upsilon^L\rho^{\tau}-D)=\rho_1^{'}-D+\overline{\upsilon}^{'}\rho^{\tau}. \tag{22}$$

Thus, for any D, fully committed insurance is feasible when $\rho_1+\overline{\upsilon}\rho^{\tau}\geq\rho_1^{'}+\overline{\upsilon}^{'}\rho^{\tau}$. In this case, D is defined as:

$$D-\overline{\upsilon}\tau-\lambda\rho=I. \tag{23}$$

By assumption 4, it is possible to find a solution $D\leq\rho_0$ to this equation. Thus, the bank breaks even and the firm captures the NPV of the project:

$$U_L\equiv\rho_1-I-\lambda\rho+\overline{\upsilon}(\rho^{\tau}-\tau)>0, \tag{24}$$

by assumption 2.

If $\rho_1+\overline{\upsilon}\rho^{\tau}<\rho_1^{'}+\overline{\upsilon}^{'}\rho^{\tau}$, then monitoring is required to implement the liquid project. Let the payment to the bank, D_M, be defined as in Equation 13. First notice that because $D_M-\upsilon^L\tau-\rho\leq\rho_0-\upsilon^L\tau-\rho$ (by assumption 5), assumption 4 ensures that $D_M\leq\rho_0$, so this payment is feasible.

First, we show when the bank has incentives to monitor and deny access to the credit line if $s=s^{'}$, given that the firm follows the equilibrium strategy ($\widehat{\lambda}=\lambda$). Conditional on the liquidity shock, if the bank does not monitor it must honor the credit line and its payoff is $-(\rho-\upsilon^L\tau-D_M)$. If the bank does monitor, it obtains a signal $s=s^{'}$ with probability μ and it can deny access to the credit line. Its payoff is then $-(1-\mu)(\rho-\upsilon^L\tau-D_M)-c$. So as long as $\mu(\rho+\upsilon^L\tau-D_M)>c$ (equation 11) it is incentive compatible for the bank to monitor even when the bank anticipates that the firm has made the correct choice and picked $\widehat{\lambda}=\lambda$. Incentive compatibility is preserved because of the "negative NPV" feature of the date-1 loan. In terms of a credit line, the bank loses money when the firm draws on the credit line. Thus, the optimal contract can rely on the bank's incentives to deny access to liquidity insurance (the credit line) in order to induce good behavior by the firm.

Given that the bank is expected to monitor, if the firm chooses the right project its payoff (after the initial contract is written) is $(1-\lambda)(\rho_1+\upsilon^H\rho^{\tau}-D_M)+\lambda(1-\mu)(\rho_1+\upsilon^L\rho^{\tau}-D_M)$, while illiquidity transformation produces the payoff $(1-\lambda^{'})(\rho_1^{'}+\upsilon^H\rho^{\tau}-D_M)$. So if:

$$(1-\lambda)(\rho_1+\upsilon^H\rho^{\tau}-D_M)+\lambda(1-\mu)(\rho_1+\upsilon^L\rho^{\tau}-D_M)>(1-\lambda^{'})(\rho_1^{'}+\upsilon^H\rho^{\tau}-D_M), \tag{25}$$

the firm will choose the liquid project.

The bank breaks even and the firm captures the NPV of the liquid project net of monitoring costs:

$$U_L^*=U_L-\lambda\left[c+\mu\left[\rho_1-\rho+\upsilon^L(\rho^{\tau}-\tau)\right]\right]. \tag{26}$$

Finally, if either equation 11 or 25 do not hold, monitoring is not incentive compatible and thus the liquid project cannot be implemented.

6.3 Proof of proposition 2

Suppose the firm chooses the illiquid project. It must then promise a payment $D^{'}$ to outside investors such that they break even:

$$D^{'}-\overline{\upsilon}^{'}\tau-\lambda\rho=I. \tag{27}$$

By assumption 4, there is a solution $D^{'} \leq \rho_0$ that satisfies this equation. Given this, and since illiquidity transformation is not an issue, the firm captures the NPV of the illiquid project which is given by:

$$U_C = \rho_1^{'} - \lambda^{'}\rho - I + \overline{\upsilon}^{'}(\rho^{\tau} - \tau).$$

6.4 Proof of proposition 3

In the case of the liquid project, the firm is given a credit line of size $\rho + \tau - \rho_0$. This credit line is sufficient to meet the firm's liquidity demand if both the liquidity shock ρ and the new investment opportunity τ arrive at date-1. If the firm reports a liquidity shock ρ, the bank has incentives to monitor given that condition 11 holds. Monitoring triggers revocation with probability μ. This revocation creates incentives for the firm to avoid illiquidity transformation, since condition 25 holds. This solution allows the firm to achieve a payoff equal to U_L^*. The bank receives a payment equal to D_M upon continuation, at date-2, which ensures that the bank breaks even.

In case of the illiquid project, the firm borrows an amount equal to $I + \rho + \tau - \rho_0$ at date 0, and saves $\rho + \tau - \rho_0$ as cash. In date-1, the firm uses the cash to finance the liquidity shock and the new investment opportunity, and returns excess cash to investors, who also receive the payment $D^{'}$ at date 2.

6.5 Proof of proposition 4

The choice between cash and credit lines is driven by the difference between U_C and U_L^*. For firms of type L:

$$\begin{aligned}(U_C - U_L^*)_L &= \rho_1^{'} - \lambda_L^{'}\rho - \rho_1 + \lambda_L\rho + (\overline{\upsilon}^{'} - \overline{\upsilon})(\rho^{\tau} - \tau) + \lambda_L\left[c + \mu(\rho_1 - \rho + \upsilon^L(\rho^{\tau} - \tau))\right] \quad (28)\\ &= \rho_1^{'} - \rho_1 - t\rho - t(\upsilon^H - \upsilon^L)(\rho^{\tau} - \tau) + \lambda_L\left[c + \mu(\rho_1 - \rho + \upsilon^L(\rho^{\tau} - \tau))\right]\end{aligned}$$

Similarly, for firms of type H:

$$(U_C - U_L^*)_H = \rho_1^{'} - \rho_1 - t\rho - t(\upsilon^H - \upsilon^L)(\rho^{\tau} - \tau) + \lambda_H\left[c + \mu(\rho_1 - \rho + \upsilon^L(\rho^{\tau} - \tau))\right]. \quad (29)$$

Thus, we have that:

$$(U_C - U_L^*)_H - (U_C - U_L^*)_L = (\lambda_H - \lambda_L)\left[c + \mu(\rho_1 - \rho + \upsilon^L(\rho^{\tau} - \tau))\right] > 0. \quad (30)$$

Thus, the difference in payoffs is larger for firms of type H which are then more likely to choose cash.

6.6 Proof of proposition 5

The difference in payoffs for the firm with high hedging needs can be written as:

$$(U_C - U_L^*)_{HHN} = K + \lambda\upsilon(\rho^{\tau} - \tau),$$

where $K = \rho_1^{'} - \rho_1 - (\lambda^{'} - \lambda)\rho + \lambda\left[c + \mu(\rho_1 - \rho)\right]$ is a term that does not depend on υ. Similarly, the difference in payoffs for the firm with low hedging needs can be written as:

$$(U_C - U_L^*)_{LHN} = K + \lambda\upsilon^L(\rho^{\tau} - \tau) + (\overline{\upsilon}^{'} - \overline{\upsilon})(\rho^{\tau} - \tau).$$

Since $\upsilon^L < \upsilon$ and $\overline{\upsilon}^{'} - \overline{\upsilon} > 0$, it follows that $(U_C - U_L^*)_{LHN} < (U_C - U_L^*)_{HHN}$.

6.7 Model extension of Section 2.4.4

In this version of the model, illiquidity transformation can be modeled as a shift in the distribution function $\widehat{F}(.)$, which also affects the expected project payoff $\widehat{\rho_1}$. Specifically, we assume that the liquid project is represented by a function $F(.)$, and an expected payoff ρ_1, while the illiquid project is represented by a function $F^{'}(.) \leq F(.)$ for all ρ, and an expected payoff $\rho_1^{'} > \rho_1$. The former condition means that the probability that ρ is below any given value ρ_X is greater under the liquid project choice. That is, the illiquid project shifts mass towards high levels of the liquidity shock. As in the model above, we assume that illiquidity transformation does not affect date-1 pledgeable income ρ_0.

In this case the optimal liquidity policy is to establish a cutoff ρ^* below which the firm is allowed to continue the project in date-1 (see Tirole (2006), p. 201-204). The cutoff ρ^* is always greater or equal to the pledgeable income ρ_0, since for $\rho < \rho_0$ continuation benefits both outside investors and the firm. In order to be able to pay for liquidity shocks above ρ_0, the firm must have access to pre-committed liquidity sources such as cash or credit lines. Increasing the cutoff up to $\rho^* = \widehat{\rho_1}$ maximizes the NPV of the project, but may not be feasible. In what follows we assume that the firm can finance the NPV-maximizing cutoffs for both the liquid and the illiquid project:

$$I + \int_0^{\rho_1^{'}} \rho f^{'}(\rho) d\rho \leq F^{'}(\rho_1^{'})\rho_0. \tag{31}$$

This condition ensures that the firm can fund the NPV-maximizing cutoff if it chooses the liquid project as well (in this case the value-maximizing cutoff is $\rho^* = \rho_1$). The liquid project has greater *date-0* expected pledgeable income since $\rho_1^{'} > \rho_1$ and $F(.) \geq F^{'}(.)$ for all ρ, and because date-1 pledgeable income (ρ_0) is the same for both projects. In other words, both projects produce the same pledgeable income contingent on continuation (ρ_0), but the illiquid project requires liquidity infusions with greater probability at date-1.

The monitoring technology is identical to the model above. For this version of the model we have:

$$\begin{aligned} \text{Prob}(s &= s^{'}/\widehat{F} = F) = \mu < 1 \\ \text{Prob}(s &= s^{'}/\widehat{F} = F^{'}) = 1. \end{aligned} \tag{32}$$

As in the model above, the bank monitors after the firm reports a given liquidity shock ρ and attempts to draw on the credit line if $\rho > \rho_0$.

We also make the following assumptions:

$$F^{'}(\rho_1)(\rho_1^{'} - \rho_0) > F(\rho_1)(\rho_1 - \rho_0), \tag{33}$$

$$\mu(\rho_1 - \rho_0) \geq c, \text{ and} \tag{34}$$

$$\left[F(\rho_0 + \frac{c}{\mu}) + (1-\mu)(F(\rho_1) - F(\rho_0 + \frac{c}{\mu})) \right] (\rho_1 - \rho_0) > F^{'}(\rho_0 + \frac{c}{\mu})(\rho_1^{'} - \rho_0). \tag{35}$$

The first assumption (condition 33) creates a role for monitoring. In order to see this, suppose that the firm wishes to implement the liquid project. Since $\rho^* = \rho_1$ is feasible, the firm would open a credit line of size $\rho_1 - \rho_0$, and use it to fund liquidity shocks above ρ_0 and up to ρ_1. Conditional on having started the project and secured a fully committed credit line, the firm's payoff is then $F(\rho_1)(\rho_1 - \rho_0)$, while the payoff from deviating to the illiquid project is $F^{'}(\rho_1)(\rho_1^{'} - \rho_0)$. Thus, as long as condition 33 holds, the firm cannot access fully committed liquidity insurance. Notice that the firm will be liquidated for $\rho > \rho_1$ even when it deviates to the illiquid project, since its credit line is of size $\rho_1 - \rho_0$.

The second assumption (condition 34) assures that the bank has incentives to monitor. In particular, the bank will monitor if and only if $\mu(\rho - \rho_0) > c$. Thus, there is a minimum level of the liquidity shock ρ that will induce bank monitoring. This is such that:

$$\mu(\rho_{\min} - \rho_0) = c. \tag{36}$$

Assumption 34 assures that $\rho_{\min} \leq \rho_1$. Firm and bank strategies are as follows (as a function of ρ): if $\rho < \rho_0$, the firm can continue the project without drawing on the credit line. If $\rho_0 \leq \rho \leq \rho_{\min}$, the firm draws on the credit line and the bank does not monitor. If $\rho_{\min} < \rho \leq \rho_1$, the bank will monitor in equilibrium and may revoke the credit line. Finally, if $\rho_1 < \rho$ the firm has no incentive to draw on the credit line because it is not sufficient to finance continuation.

The third assumption (condition 35) assures that bank monitoring is sufficient to induce the firm not to deviate to the illiquid project once the credit line is in place (see the proof to Proposition 6). The firm's ex-ante payoff under the monitored credit line is:

$$U^{LC} = F(\rho_1)\rho_1 - I - \int_0^{\rho_1} \rho f(\rho) d\rho - \int_{\rho_{\min}}^{\rho_1} \left[c + \mu(\rho_1 - \rho)\right] f(\rho) d\rho. \tag{37}$$

The expression $F(\rho_1)\rho_1 - I - \int_0^{\rho_1} \rho f(\rho) d\rho$ represents the firm's liquid project payoff under fully committed liquidity insurance. The term $\int_{\rho_{\min}}^{\rho_1} \left[c + \mu(\rho_1 - \rho)\right] f(\rho) d\rho$ represents the monitoring cost. If $\rho_{\min} < \rho < \rho_1$, the bank monitors (at cost c), and the credit line is revoked with probability μ, implying a value loss $\rho_1 - \rho$ for each ρ.

The firm's alternative is to use cash, and to invest in the illiquid project. In this case, the payoff is:

$$U^C = F^{'}(\rho_1^{'})\rho_1^{'} - I - \int_0^{\rho_1^{'}} \rho f^{'}(\rho) d\rho \tag{38}$$

Condition 31 ensures that both payoffs are achievable. As in the previous model, the firm chooses cash when $U^C \geq U^{LC}$, and the credit line otherwise. The main result of this extension is as follows:

Proposition 6 *Under assumptions 31, 33, 34, and 35, a decrease in pledgeable income ρ_0 makes it more likely that the firm will choose cash instead of the credit line. That is, $U^{LC} - U^C$ is increasing in ρ_0.*

Given the bank's monitoring strategy, the firm's payoff conditional on having started a project and secured a credit line of size $\rho_1 - \rho_0$ is:

$$\left[F(\rho_{\min}) + (1 - \mu)(F(\rho_1) - F(\rho_{\min}))\right](\rho_1 - \rho_0) \tag{39}$$

If $\rho < \rho_{\min}$, the firm can continue the project with probability one because the bank does not monitor. If $\rho_{\min} < \rho < \rho_1$, then the bank monitors and revokes the credit line with probability μ.

If the firm deviates to the illiquid project, the payoff is:

$$F^{'}(\rho_{\min})(\rho_1^{'} - \rho_0). \tag{40}$$

In this case the bank revokes the credit line with probability one if $\rho > \rho_{\min}$.

As long as $[F(\rho_{\min}) + (1-\mu)(F(\rho_1) - F(\rho_{\min}))]\,(\rho_1 - \rho_0) > F^{'}(\rho_{\min})(\rho_1^{'} - \rho_0)$, the firm can implement the liquid project using a monitored credit line.

The monitored credit line is feasible if:

$$I + \int_0^{\rho_1} \rho f(\rho) d\rho \leq F(\rho_1)\rho_0 + \int_{\rho_{\min}}^{\rho_1} [\mu(\rho - \rho_0) - c]\, f(\rho) d\rho \tag{41}$$

This condition is implied by equation 31 above, since the expression $\int_{\rho_{\min}}^{\rho_1} [\mu(\rho - \rho_0) - c]\, f(\rho) d\rho$ is positive, and because $\rho_1^{'} > \rho_1$ and $F(.) \geq F^{'}(.)$ for all ρ. Thus, the payoff under the credit line is given by equation 37.

The feasibility condition for the cash solution is $I + \int_0^{\rho_1^{'}} \rho f^{'}(\rho) d\rho \leq F^{'}(\rho_1^{'})\rho_0$, which is exactly condition 31. In this case the firm holds an amount of cash equal to $\rho_1^{'} - \rho_0$, and uses it to fund liquidity shocks up to $\rho_1^{'}$ at date 1. Thus, the payoff is given by equation 38.

To derive the comparative statics, notice that the expression U^C does not depend on ρ_0. In contrast, U^{LC} is increasing in $\rho_{\min}$, which is increasing in ρ_0 by equation 36. Thus, the difference $U^C - U^{LC}$ decreases in ρ_0.

Figure 1 Timeline of Model

Figure 1a

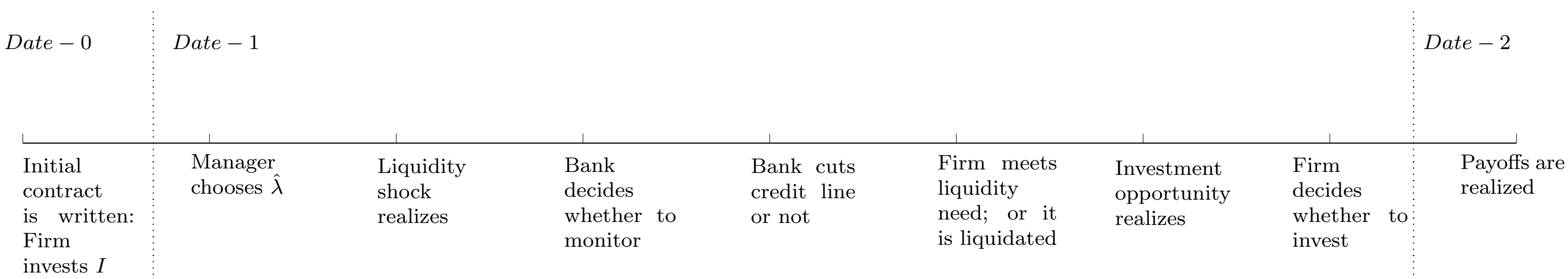


Figure 1b

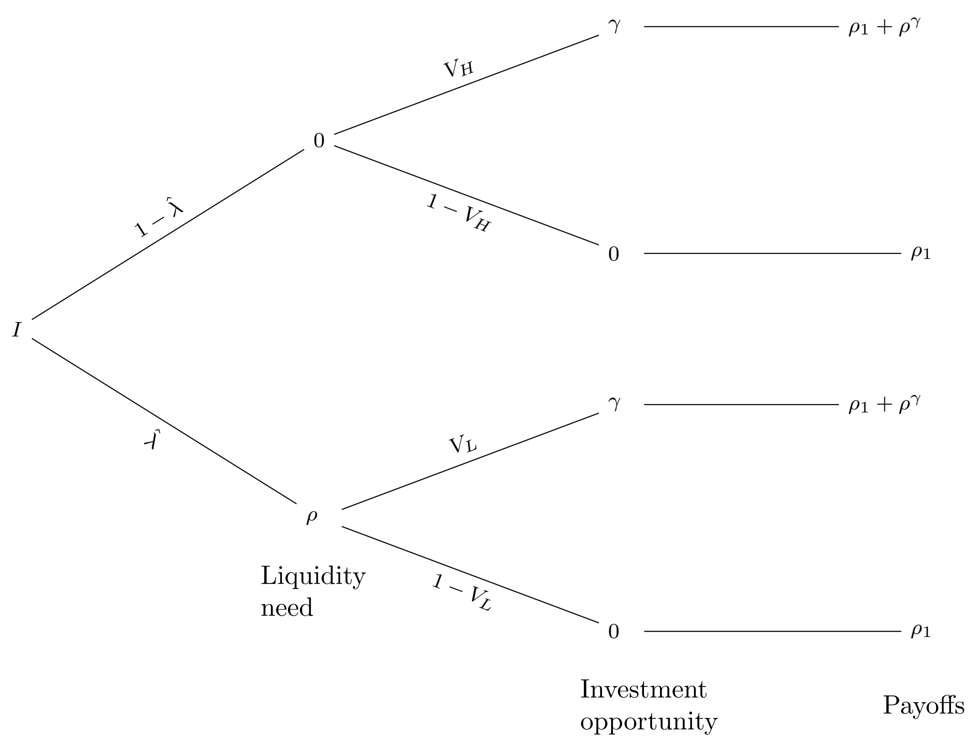
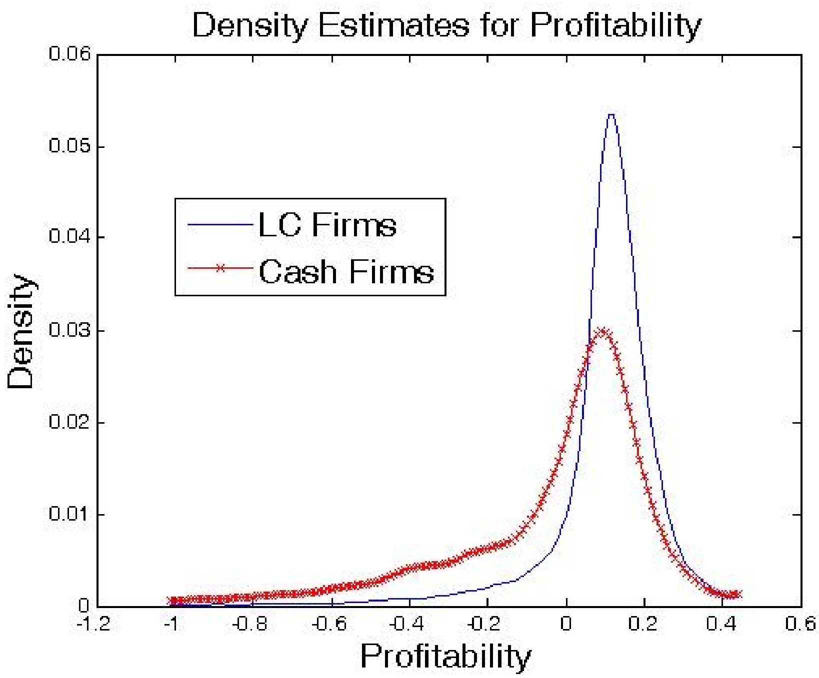


Figure 2. Distribution of Liquidity Shocks

This figure presents evidence on the differences in the distribution of profitability and cash flows over assets between firms with a credit line ("LC Firms") and firms without one ("Cash Firms"). The probability density displayed is an estimate using the data in the sample based on a normal kernel function and evaluated at 100 equally spaced points that cover the range of the data winsorized at the 0.5% level on both tails.



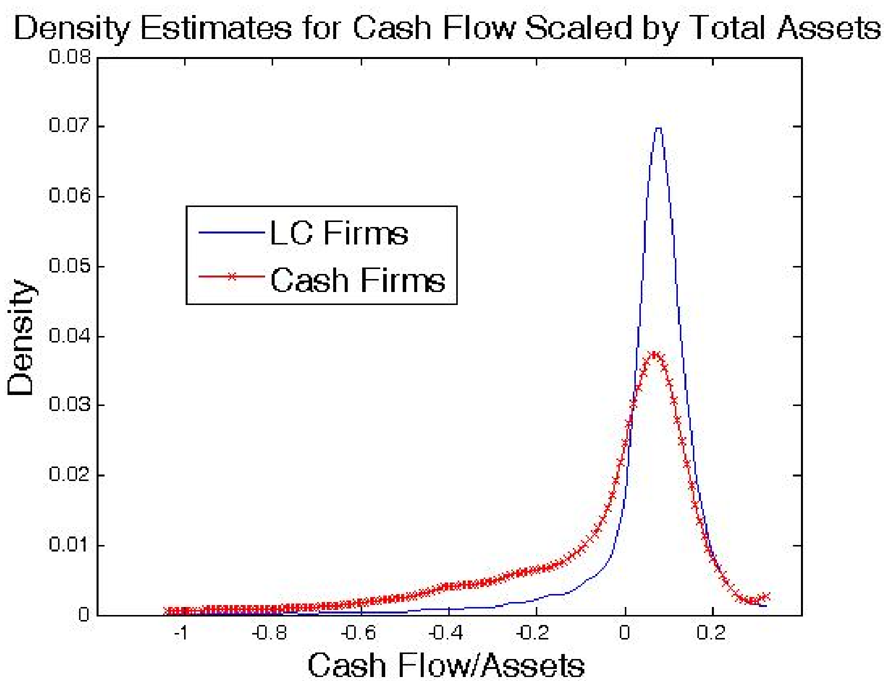


Table 1. Comparison of Firms with and without Credit Lines

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

	(1)	(2)	(3)	(4)	(5)
	Entire Sample	Sample of Firms with a Credit Line	Sample of Firms without a Credit Line	Test of Difference with vs. without a Credit Line	
	Mean [Median]	Mean [Median]	Mean [Median]	t-test p-value	MW p-value
Cash/ Net At	0.657	0.350	1.517	45.658	80.044
	[0.147]	[0.094]	[0.576]	(0.000)	(0.000)
Credit Lines/Net At	0.106	0.156			
	[0.071]	[0.124]			
Cash/ Net At	0.115	0.093	0.185	33.527	50.649
(market value)	[0.054]	[0.043]	[0.100]	(0.000)	(0.000)
Credit Lines/Net At	0.067	0.096			
(market value)	[0.041]	[0.071]			
Profitability	0.059	0.097	-0.048	-46.411	-52.245
	[0.107]	[0.119]	[0.045]	(0.000)	(0.000)
Size	2181.0	2618.9	952.8	-30.560	-55.191
	[317.2]	[453.8]	[118.5]	(0.000)	(0.000)
Book Leverage	0.211	0.232	0.151	-30.678	-49.071
	[0.152]	[0.192]	[0.017]	(0.000)	(0.000)
M/B	1.728	1.576	2.195	28.841	32.753
	[1.232]	[1.152]	[1.582]	(0.000)	(0.000)
Tangibility	0.248	0.273	0.177	-39.567	-47.168
	[0.167]	[0.197]	[0.094]	(0.000)	(0.000)
NWC/At	0.050	0.076	-0.019	-43.110	-44.129
	[0.042]	[0.064]	[-0.015]	(0.000)	(0.000)
Capex/At	0.054	0.057	0.045	-16.503	-32.671
	[0.033]	[0.036]	[0.023]	(0.000)	(0.000)
R&D/Sales	0.370	0.136	1.034	29.731	63.398
	[0.005]	[0.000]	[0.106]	(0.000)	(0.000)
Dividend Payer	0.275	0.330	0.117	-49.989	-40.888
	[0.000]	[0.000]	[0.000]	(0.000)	(0.000)
Beta KMV	1.245	1.176	1.419	13.428	12.227
	[1.099]	[1.054]	[1.247]	(0.000)	(0.000)
Rating Dummy	0.265	0.327	0.092	-59.701	-46.715
	[0.000]	[0.000]	[0.000]	(0.000)	(0.000)
Observations	32671	22186	10485		

Table 2. The Effect of the GM-Ford Crisis on Liquidity Management

This table examines how the GM-Ford crisis affected liquidity management. We construct three measures of bond dependence: 1. Bonds/Assets; 2. Dummy for firms with bonds greater than 50% of debt; 3. Dummy for being rated. For each of these variables we compute the average at the three-digit SIC in 2003, and the average over the whole sample. The industry dummies take value one if the industry average is above the sample average. These dummies identify three separate "treatment groups" respectively employed in panels A-C. The dummy for the crisis equals one if the annual report falls in the period that goes from December 2004 to May 2005. The interaction term is the product of the "treatment group" dummies and the crisis dummy. We regress four measures of liquidity (Columns 1-4) on the crisis, treatment and interaction dummies controlling for (unreported) firm profitability, size, M/B, tangibility, NWC/assets, Capex/assets, R&D/Sales, dividend payer, Beta KMV, rating dummy. We drop firms in the auto sectors. We include only firm-years for which reporting occurred during any month of the fiscal years 2003-2004. We cluster errors at the firm level.

	(1) Cash / (Cash + Credit Lines)	(2) Cash / Net Assets	(3) Undrawn Credit Lines/Net Assets	(4) Total Liquidity / Net Assets
Panel A: Sort by Industry Average Bonds/Assets Ratio				
Crisis Dummy	-0.019**	-0.024***	0.002	-0.023***
	(0.009)	(0.004)	(0.003)	(0.005)
Treat. Dummy	-0.074***	-0.021***	0.011**	-0.009
	(0.014)	(0.006)	(0.005)	(0.007)
Treatment*Crisis	0.032**	0.020***	-0.012**	0.008
	(0.013)	(0.006)	(0.005)	(0.008)
R squared	0.390	0.405	0.177	0.197
Panel B: Sort by Industry Percentage of Firms with at least 50% of Debt in Bonds				
Crisis Dummy	-0.018**	-0.023***	0.002	-0.022***
	(0.009)	(0.005)	(0.003)	(0.006)
Treat. Dummy	-0.054***	-0.010*	0.013***	0.002
	(0.014)	(0.006)	(0.005)	(0.007)
Treatment*Crisis	0.025**	0.015**	-0.011**	0.005
	(0.013)	(0.006)	(0.005)	(0.008)
R squared	0.387	0.403	0.178	0.197
Panel C: Sort by Industry Percentage of Firms that are Rated				
Crisis Dummy	-0.015*	-0.029***	0.000	-0.029***
	(0.008)	(0.005)	(0.003)	(0.006)
Treat. Dummy	-0.082***	-0.020***	0.017***	-0.003
	(0.016)	(0.006)	(0.005)	(0.007)
Treatment*Crisis	0.028**	0.032***	-0.009*	0.024***
	(0.013)	(0.006)	(0.005)	(0.007)
R squared	0.391	0.405	0.179	0.198
Observations	4,705	4,689	4,707	4,689

Table 3. Liquidity Management During a Placebo Event

This table provides a robustness check on Table 2 using a different definition of crisis. We construct a dummy for the crisis if the annual report falls in the period that goes from December 2003 to May 2004.

	(1) Cash / (Cash + Credit Lines)	(2) Cash / Net Assets	(3) Undrawn Credit Lines/Net At	(4) Total Liquidity / Net Assets
Panel A: Sort by Industry Average Bonds/Assets Ratio				
Crisis Dummy	-0.056***	0.001	0.010***	0.010*
	(0.008)	(0.005)	(0.003)	(0.005)
Treat. Dummy	-0.051***	-0.017***	0.004	-0.013*
	(0.013)	(0.006)	(0.005)	(0.007)
Treatment*Crisis	0.004	0.013**	-0.001	0.012*
	(0.013)	(0.006)	(0.004)	(0.007)
R squared	0.309	0.409	0.134	0.205
Panel B: Sort by Industry Percentage of Firms with at least 50% of Debt in Bonds				
Crisis Dummy	-0.058***	0.001	0.011***	0.012**
	(0.009)	(0.005)	(0.003)	(0.006)
Treat. Dummy	-0.060***	-0.014**	0.009**	-0.006
	(0.013)	(0.006)	(0.004)	(0.007)
Treatment*Crisis	0.008	0.011*	-0.004	0.007
	(0.013)	(0.006)	(0.004)	(0.008)
R squared	0.310	0.409	0.135	0.204
Panel C: Sort by Industry Percentage of Firms that are Rated				
Crisis Dummy	-0.052***	0.004	0.007***	0.011**
	(0.008)	(0.005)	(0.003)	(0.005)
Treat. Dummy	-0.072***	-0.023***	0.009*	-0.013*
	(0.015)	(0.006)	(0.005)	(0.007)
Treatment*Crisis	-0.002	0.006	0.004	0.011
	(0.013)	(0.006)	(0.005)	(0.007)
R squared	0.312	0.410	0.136	0.204
Observations	4,775	4,759	4,777	4,759

Table 4. How Was the Increase in Cash Financed during the GM-FORD Event?

In Panel A this table examines how the increase in cash holdings was financed for bond-dependent firms during the GM-FORD event. In Panel B it shows how much of the credit lines were drawn. We construct three measures of bond dependence: 1. Dummy for bonds greater than 5% of assets; 2. Dummy for firms with bonds greater than 50% of debt; 3. Dummy for being rated. We construct a dummy for the crisis if the annual report falls in the period that goes from December 2004 to May 2005. In Panel A we regress the change in cash holdings on various items from the cash flow statement, for firms with bonds during the crisis (columns 1, 3 and 5) outside the crisis (columns 2, 4 and 6) in the three subsets of bond-dependent firms. In Panel B we regress the change in undrawn credit lines on the change in drawn credit lines, controlling for a number of firm characteristics, across different subsets as in Panel A. Controls include (unreported) firm profitability, size, M/B, tangibility, NWC/assets, Capex/assets, R&D/Sales, dividend payer, and a rating dummy. We cluster errors at the firm level.

	(1)	(2)	(3)	(4)	(5)	(6)
	Firms with Bonds		Firms with Bonds/D>50%		Rated Firms	
	In crisis	Not in crisis	In crisis	Not in crisis	In crisis	Not in crisis
Panel A: Change in Cash Holdings Year on Year						
Net Income + Depr.	0.101***	0.094***	0.102***	0.110***	0.077***	0.085***
	(0.028)	(0.011)	(0.029)	(0.011)	(0.029)	(0.010)
Capex	-0.032	-0.061***	-0.022	-0.083***	-0.002	-0.049***
	(0.045)	(0.015)	(0.048)	(0.017)	(0.046)	(0.015)
Change WC	-0.245***	-0.241***	-0.236***	-0.259***	-0.240***	-0.256***
	(0.048)	(0.020)	(0.049)	(0.021)	(0.049)	(0.020)
Dividends	0.107	-0.126***	0.028	-0.184***	0.171	-0.115**
	(0.130)	(0.046)	(0.132)	(0.049)	(0.132)	(0.047)
Net Equity Issues	0.114***	0.066***	0.126***	0.078***	0.119***	0.069***
	(0.024)	(0.011)	(0.026)	(0.011)	(0.026)	(0.011)
Net Debt Issues	0.044	0.073***	0.044	0.086***	0.015	0.050***
	(0.028)	(0.012)	(0.032)	(0.014)	(0.030)	(0.012)
Constant	3.416	6.608***	4.868*	8.355***	6.492	8.395***
	(2.548)	(1.019)	(2.592)	(1.035)	(4.419)	(1.694)
Observations	1,002	6,045	949	5,590	666	4,093
R-squared	0.211	0.111	0.213	0.126	0.189	0.105
Panel B: Change in Undrawn Credit Lines Year on Year						
Change in Drawn CL	-0.572***	-0.481***	-0.564***	-0.474***	-0.568***	-0.473***
	(0.135)	(0.042)	(0.156)	(0.051)	(0.154)	(0.047)
Observations	833	5,066	790	4,656	585	3,547
R-squared	0.089	0.077	0.091	0.074	0.081	0.066

Table 5. The Effect of Mutual Fund Redemptions on Liquidity Management

This table examines how price pressure by fund outflows relates to liquidity management. We compute fund outflows as the absolute value of *MFFlow* as in Edmans, Goldstein and Jiang (2011). Our outflow variable measures the sale of a firm's equity as a percentage of its dollar trading volume, associated with mutual fund outflows greater than 5%.
All regressions include the following (unreported) firm characteristics: industry cash flow volatility, size, M/B, tangibility, NWC/assets, Capex/assets, R&D/Sales, dividend payer, rating dummy. We cluster errors at the firm level.

	(1) Cash / (Cash + Credit Lines)	(2) Cash / Net Assets	(3) Undrawn Credit Lines/Net At	(4) Total Liquidity / Net Assets
Panel A: Dummy Equals One if the Firm Has Been Subject to an Outflow				
Dummy Outflow	0.013**	0.004	-0.005**	-0.002
	(0.007)	(0.009)	(0.003)	(0.009)
R squared	28,934	28,854	28,946	28,814
Observations	0.357	0.280	0.101	0.229
Panel B: Continuous Measure of Outflow				
Outflow	0.473***	-0.590***	-0.123*	-0.712***
	(0.103)	(0.058)	(0.071)	(0.086)
R squared	28,934	28,854	28,946	28,814
Observations	0.356	0.280	0.101	0.229
Panel C: Continuous Measure of Outflow Conditional on Having an Outflow				
Outflow	0.555***	-0.589***	-0.177***	-0.766***
	(0.101)	(0.089)	(0.066)	(0.079)
Observations	12,173	12,131	12,176	12,115
R squared	0.385	0.257	0.110	0.186

Table 6. Credit Line Usage across Top and Bottom Quintiles of Hedging Needs

This table provides summary statistics across groups of high versus low correlation of investment opportunities and cash-flow (*low* and *high hedging needs*, respectively). Hedging needs are calculated at the 3-digit SIC code industry level as the correlation between mean industry annual cash flow and, respectively, mean industry annual investment activities (*Hedging Investment Activities*, item 311 + 46), and mean industry annual Tobin's Q (*Hedging Tobin's Q*). High (low) hedging needs firms are those with a correlation in the bottom (top) quintile. In Panel A we examine the relationship between hedging needs and four liquidity variables. In Panel B we first regress the four liquidity variables on a set of firm characteristics (profitability, size, book leverage, M/B, tangibility, NWC/assets, capex/assets, R&D/sales, dividend payer dummy, CF volatility, beta KMV, and rating), and then relate the residuals of those regressions to hedging needs. In both panels we include a test for differences between samples with high and low hedging needs using the unequal variances t-test.

Panel A	Variable: Mean (Median)			
	Presence of a Credit Line (Dummy)	Undrawn Credit / Net Assets	Undrawn Credit / Total Liquidity	Revolving Credit /Net Assets
Industry median Invest. Activities				
High hedging needs	0.540	0.079	0.233	0.023
N= 6704	(1.000)	(0.015)	(0.054)	(0.000)
Low hedging needs	0.818	0.126	0.536	0.050
N= 6545	(1.000)	(0.102)	(0.595)	(0.000)
t-test	36.022	21.930	52.958	18.928
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)
Industry median Tobin's Q				
High hedging needs	0.602	0.096	0.304	0.027
N= 6611	(1.000)	(0.044)	(0.177)	(0.000)
Low hedging needs	0.797	0.129	0.493	0.044
N=6133	(1.000)	(0.105)	(0.538)	(0.000)
t-test	24.653	14.703	31.148	11.982
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)

Panel B	Residuals: Mean (Median)			
	Presence of a Credit Line (Dummy)	Undrawn Credit / Net Assets	Undrawn Credit / Total Liquidity	Revolving Credit /Net Assets
Industry median Invest. Activities				
High hedging needs	-0.055	-0.011	0.237	0.023
N= 6815	0.296	-0.044	0.058	0.000
Low hedging needs	0.237	0.006	0.535	0.050
N= 6518	0.410	-0.018	0.594	0.000
t-test	15.224	7.566	52.086	18.947
(p-value)	0.000	0.000	0.000	0.000
Industry median Tobin's Q				
High hedging needs	0.106	0.005	0.304	0.027
N= 6611	0.405	-0.029	0.177	0.000
Low hedging needs	0.182	0.004	0.493	0.044
N=6133	0.396	-0.021	0.538	0.000
t-test	3.935	-0.442	31.148	11.982
(p-value)	0.000	0.659	0.000	0.000

Table 7. Hedging Needs and Covenants on Credit Lines

This table estimates the relationship between hedging needs and the use of covenants on credit lines using a Poisson specification. We obtain data on covenants from LPC Dealscan. We list all the covenants attached to credit lines for the firms in our sample during the period 2002-2008. When firms are granted several new credit line facilities in the same year we report the median value. *General Purpose LC* is a dummy that takes value 1 if the stated purpose of the line of credit is "General Corporate Purposes", as reported in LPC Dealscan. All regressions include year fixed effects. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels, respectively.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
	Covenant Index Drucker and Puri (2010)		Covenant Index Demiroglu and James (2010)		Covenant Index Only CF Covenants		Covenant Index Only Sweeps	
Correlation Inv. Activities	-0.079***		-0.077***		-0.208***		-0.170***	
	(0.026)		(0.030)		(0.041)		(0.047)	
Correlation Tobin's Q		-0.058**		-0.035		-0.148***		-0.170***
		(0.027)		(0.031)		(0.042)		(0.047)
Profitability	0.208*	0.205*	-0.162	-0.175	0.248	0.221	-0.254	-0.244
	(0.112)	(0.112)	(0.122)	(0.122)	(0.176)	(0.176)	(0.196)	(0.198)
Size	-0.240***	-0.241***	-0.242***	-0.243***	-0.275***	-0.279***	-0.360***	-0.362***
	(0.008)	(0.008)	(0.010)	(0.010)	(0.013)	(0.013)	(0.015)	(0.015)
Book Leverage	0.698***	0.704***	0.718***	0.723***	0.764***	0.769***	1.405***	1.408***
	(0.046)	(0.046)	(0.053)	(0.053)	(0.071)	(0.071)	(0.075)	(0.075)
MB	-0.100***	-0.098***	-0.139***	-0.136***	-0.103***	-0.096***	-0.200***	-0.196***
	(0.012)	(0.012)	(0.014)	(0.014)	(0.019)	(0.019)	(0.024)	(0.024)
Rated	0.155***	0.148***	0.141***	0.133***	0.119***	0.114***	0.343***	0.337***
	(0.026)	(0.026)	(0.030)	(0.030)	(0.042)	(0.042)	(0.047)	(0.047)
CF Volatility	-1.968***	-2.030***	-1.435**	-1.481**	-1.756*	-1.840**	-1.872*	-2.039*
	(0.591)	(0.592)	(0.650)	(0.652)	(0.921)	(0.922)	(1.076)	(1.083)
General Purpose LC	-0.226***	-0.230***	-0.249***	-0.254***	-0.218***	-0.224***	-0.395***	-0.405***
	(0.020)	(0.020)	(0.023)	(0.023)	(0.032)	(0.032)	(0.035)	(0.035)
Ln(Maturity) of LC	0.406***	0.407***	0.472***	0.473***	0.472***	0.473***	0.747***	0.744***
	(0.022)	(0.022)	(0.026)	(0.026)	(0.036)	(0.036)	(0.045)	(0.045)
Facility Amount/At	-0.600***	-0.613***	-0.185**	-0.209***	-0.848***	-0.889***	-1.275***	-1.298***
	(0.073)	(0.072)	(0.079)	(0.078)	(0.116)	(0.115)	(0.136)	(0.135)
Observations	4,667	4,634	4,667	4,634	4,667	4,634	4,667	4,667
Pseudo R^2	0.0967	0.0995	0.0994	0.0826	0.0820	0.138	0.138	0.0967

Table 8. Revocations and Drawdowns

This table presents Probit (marginal effects dF/dx) and OLS regression results for the contemporaneous relationship between restriction of access to credit lines, profitability and hedging needs (columns 1-4), and for the relationship between drawdown of credit lines, profitability and hedging needs (columns 5-6). In columns 1-2 the dependent variable is a dummy for a full revocation of the credit line. In columns 3-4 the dependent variable is a dummy for a decrease in undrawn credit greater than 50% of the outstanding amount. In columns 5-6 the dependent variable is the annual change in drawn credit lines as a percentage of total assets. Year, Rating and Exchange fixed effects included. Rating fixed effects are based on 22 rating dummies and the unrated dummy. Robust standard errors clustered at the firm level are reported in parentheses. ***, **, and * denote statistical significance at the 1%, 5%, and 10% levels. All regressions include a constant term (unreported).

	(1)	(2)	(3)	(4)	(5)	(6)
	Full Revocation of Credit Line (Dummy)		Full or Partial (>50%) Revocation of Credit Line (Dummy)		Drawdown of Credit Lines	
Hedging Inv Act	-0.009***		-0.012**		0.001	
	(0.003)		(0.006)		(0.001)	
Hedging Tobin's Q		-0.010***		-0.014**		0.003**
		(0.004)		(0.006)		(0.001)
Profitability	-0.051***	-0.050***	-0.113***	-0.111***	-0.024***	-0.023***
	(0.010)	(0.010)	(0.018)	(0.018)	(0.007)	(0.007)
Size	-0.000	-0.001	-0.002	-0.002	0.001	0.001
	(0.001)	(0.001)	(0.002)	(0.002)	(0.000)	(0.000)
Book Leverage	-0.037***	-0.038***	-0.047***	-0.050***	0.046***	0.046***
	(0.008)	(0.008)	(0.013)	(0.013)	(0.005)	(0.004)
M/B	0.003***	0.004***	0.003	0.003*	-0.001*	-0.001*
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Tangibility	-0.021**	-0.016*	-0.008	-0.004	-0.026***	-0.026***
	(0.009)	(0.009)	(0.014)	(0.014)	(0.004)	(0.004)
NWC/Assets	-0.070***	-0.070***	-0.142***	-0.142***	-0.004	-0.005
	(0.008)	(0.008)	(0.014)	(0.014)	(0.004)	(0.004)
Capex/Assets	-0.033	-0.039	-0.226***	-0.224***	0.172***	0.171***
	(0.033)	(0.032)	(0.055)	(0.054)	(0.020)	(0.019)
R&D/Sales	0.001	0.001	-0.002	-0.001	-0.002	-0.002
	(0.002)	(0.002)	(0.003)	(0.003)	(0.001)	(0.001)
Div. Payer Dummy	-0.014***	-0.014***	-0.020***	-0.020***	0.005***	0.005***
	(0.003)	(0.003)	(0.005)	(0.005)	(0.001)	(0.001)
CF Volatility	0.066	0.068	0.341***	0.338***	-0.237***	-0.239***
	(0.054)	(0.054)	(0.088)	(0.087)	(0.031)	(0.031)
Beta KMV	0.002*	0.002*	0.002	0.002	0.000	0.000
	(0.001)	(0.001)	(0.002)	(0.002)	(0.001)	(0.001)
Observations	14,874	14,998	14,887	15,011	14,931	15,058
R-squared	0.141	0.142	0.093	0.093	0.059	0.059

Table 9. Probability of a Liquidity Event

This table examines the probability of a drawdown in credit lines or a reduction in cash associated with a drop in profitability. In Panel A, we compute the probability of profitability falling below 0% and 5%, respectively for firms with and without a credit line. In Panel B, we define *liquidity events* as follows: for credit line drawdowns, a liquidity event occurs if there is an increase in drawn revolving credit (ΔRC>0) while profitability is negative; for cash, a liquidity event occurs if there is a reduction in cash (ΔCash and ST Investments<0) while profitability is negative. The probability of a liquidity event for credit lines is computed as the ratio of credit line liquidity events divided by the number of firm-years with a credit line. The probability of a liquidity event for cash is computed as the ratio of cash liquidity events divided by the number of firm years without a credit line.

Panel A: Probability of a negative cash flow shock

	With Credit Line	W/out Credit Line	t-stat	*p-value*	wilcoxon	*p-value*
Probability of Profits < 0%	0.128	0.368	52.644	(0.000)	59.627	(0.000)
Probability of Profits < 5%	0.203	0.476	55.001	(0.000)	58.113	(0.000)

Panel B: Probability of a liquidity event

	Credit Line	Cash	t-stat	*p-value*	wilcoxon	*p-value*
Probability of a Liquidity Event	0.016	0.185	40.494	(0.000)	58.691	(0.000)
Probability of a Liquidity Event > 0.5% of Assets	0.014	0.179	39.726	(0.000)	57.833	(0.000)

Tables for the Appendix

Table A1. Access to Credit Lines

This table relates firm characteristics to various liquidity measures. In column (1) and (2) we run Probit regressions (marginal effects dF/dx) for the presence of a credit line, where the dependent variable is a dummy that takes value one, if the firm has an undrawn credit line. Column (1) is for all the firms in the sample, while column (2) is for the sub-sample of rated firms (>CCC). In columns (3) and (4) we run OLS regressions for cash and short-term investments as a percentage of total liquidity. Total liquidity is computed as cash and short-term investments plus undrawn credit. Column (3) is for sub-sample of rated firms (>CCC), while column (4) is for the sub-sample of rated firms that have a credit line. In column (5) we run an OLS regression for cash and short-term investments as a percentage of total assets, on the sub-sample of rated firms (>CCC) with a credit line. Year and Exchange fixed effects 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.

	(1)	(2)	(3)	(4)	(5)
	Presence of a Credit Line (Dummy)		Cash/ Total Liquidity		Cash/ Net Assets
	All Firms	Rated	Rated	Rated with a LC	Rated with a LC
Profitability	0.362***	0.116*	-0.190**	0.041	-0.078
	(0.041)	(0.069)	(0.086)	(0.087)	(0.080)
Size	0.002	-0.013**	0.048***	0.041***	-0.003
	(0.005)	(0.006)	(0.007)	(0.007)	(0.004)
Book Leverage	0.271***	0.080***	-0.338***	-0.314***	-0.202***
	(0.034)	(0.028)	(0.037)	(0.035)	(0.032)
M/B	-0.035***	-0.029***	0.082***	0.055***	0.061***
	(0.005)	(0.006)	(0.009)	(0.009)	(0.011)
Tangibility	0.201***	0.043	-0.156***	-0.093***	-0.119***
	(0.039)	(0.032)	(0.038)	(0.034)	(0.018)
NWC/Assets	0.504***	0.134***	-0.430***	-0.410***	-0.286***
	(0.036)	(0.043)	(0.056)	(0.053)	(0.036)
Capex/Assets	0.210*	0.015	-0.553***	-0.637***	-0.126***
	(0.126)	(0.123)	(0.137)	(0.115)	(0.043)
R&D/Sales	-0.023**	-0.304***	0.037*	0.878***	0.555***
	(0.009)	(0.084)	(0.022)	(0.155)	(0.159)
Div. Payer Dum.	0.076***	0.015	-0.071***	-0.058***	-0.006
	(0.015)	(0.011)	(0.015)	(0.014)	(0.008)
CF Volatility	-2.172***	-0.977**	3.591***	2.948***	1.059***
	(0.555)	(0.382)	(0.537)	(0.596)	(0.323)
Beta KMV	-0.004	0.002	0.029***	0.031***	0.017***
	(0.003)	(0.004)	(0.005)	(0.005)	(0.003)
Rating	-0.009***	-0.012***	0.019***	0.017***	0.008***
	(0.001)	(0.003)	(0.004)	(0.003)	(0.002)
Observations	23,653	6,848	6,839	6,166	6,172
R-squared	0.272	0.259	0.287	0.286	0.239

Table A2. How does Liquidity Management vary over Different States of the Economy?

This table examines how liquidity management varies across different states of the economy, measured by bond spreads, equity market returns, and GDP growth. Bond spreads are the average spreads on AAA and BAA Moody's rated bonds. Hot Bond Market is a dummy that takes one if the average bond spreads are one standard deviation below the median over the whole period. We compute GDP growth as the annual percentage change in GDP in the US. We compute equity returns as the annual percentage change on the S&P500 index. Industry mean cash flow volatility and bonds percentage of assets are computed at the three-digit SIC level. All regressions include the following (unreported) firm characteristics: size, M/B, tangibility, NWC/assets, Capex/assets, R&D/Sales, dividend payer, rating dummy. We cluster errors at the firm level.

	(1) Cash / (Cash + Credit Lines)	(2) Cash / Net Assets	(3) Undrawn Credit Lines/Net At	(4) Total Liquidity /Net Assets
Panel A: Hot Bond Markets and Average Industry Bonds /Assets				
Hot Bond Market	-0.036***	-0.040***	0.001	-0.038***
	(0.003)	(0.008)	(0.002)	(0.008)
Ind. Mean Bonds /At	-0.061***	0.005	0.002	0.006
	(0.009)	(0.012)	(0.003)	(0.012)
Hot Bond Market* Ind. Mean Bonds /At	-0.005	0.002	0.001	0.003
	(0.005)	(0.011)	(0.002)	(0.011)
Observations	28,948	28,814	28,946	28,814
R squared	0.326	0.278	0.088	0.226
Panel B: Hot Bond Markets and Industry Percentage of Firms with at least 50% of Debt in Bonds				
Hot Bond Market	-0.030***	-0.048***	0.001	-0.047***
	(0.003)	(0.009)	(0.002)	(0.009)
Ind.Perc.Bonds>50	-0.070***	-0.024**	0.010***	-0.014
	(0.010)	(0.009)	(0.003)	(0.010)
Hot Bond Market* Ind.Perc.Bonds>50	-0.018***	0.023**	0.001	0.025**
	(0.005)	(0.010)	(0.002)	(0.010)
Observations	28,948	28,854	28,946	28,814
R squared	0.329	0.278	0.089	0.226
Panel C: Hot Bond Markets and Industry Percentage of Firms that are Rated				
Hot Bond Market	-0.029***	-0.051***	0.001	-0.050***
	(0.003)	(0.008)	(0.002)	(0.009)
Ind.Perc. of Rated	-0.087***	-0.028***	0.014***	-0.014
	(0.010)	(0.009)	(0.003)	(0.009)
Hot Bond Market* Ind.Perc. of Rated	-0.021***	0.032***	0.002	0.034***
	(0.005)	(0.010)	(0.003)	(0.010)
Observations	28,948	28,854	28,946	28,814
R squared	0.333	0.278	0.090	0.226
Panel D: GDP Growth and Average Industry CF Volatility				
GDP Growth	-0.521***	-0.947***	0.008	-0.942***
	(0.059)	(0.115)	(0.027)	(0.118)
R squared	28,272	28,180	28,271	28,142
Observations	0.327	0.282	0.089	0.229
Panel E: Equity Markets Retuns and Average Industry CF Volatility				
Equity Returns	-0.090***	-0.005	0.028***	0.023**
	(0.006)	(0.010)	(0.003)	(0.011)
R squared	28,272	28,180	28,271	28,142
Observations	0.328	0.280	0.091	0.227

Table A3. Was there a reversal of the cash accumulation after the GM-FORD event?

This table replicates the analysis of Table 2. The treatment group is constructed as in the main analysis. The crisis dummy is replaced by a dummy (*post dummy*)for the twelve months following the GM-FORD event (July 2005 – June 2006). We include only observations in Compustat fiscal years 2004 and 2005 (June 2004 – June 2006).

	(1) Cash / (Cash + Credit Lines)	(2) Cash / Net Assets	(3) Undrawn Credit Lines/Net At	(4) Total Liquidity / Net Assets
Panel A: Sort by Industry Average Bonds/Assets Ratio				
Post Dummy	0.004	0.006*	0.000	0.006
	(0.007)	(0.003)	(0.003)	(0.004)
Treat. Dummy	-0.052***	-0.012**	0.004	-0.007
	(0.014)	(0.005)	(0.005)	(0.007)
Treatment*Post	-0.005	-0.002	0.001	-0.001
	(0.010)	(0.005)	(0.004)	(0.006)
R squared	0.307	0.335	0.105	0.159
Panel B: Sort by Industry Percentage of Firms with at least 50% of Debt in Bonds				
Post Dummy	0.009	0.008**	0.000	0.008*
	(0.007)	(0.004)	(0.003)	(0.005)
Treat. Dummy	-0.050***	-0.010*	0.010**	0.001
	(0.014)	(0.006)	(0.005)	(0.007)
Treatment*Post	-0.015	-0.006	0.001	-0.005
	(0.010)	(0.005)	(0.004)	(0.006)
R squared	0.308	0.335	0.107	0.158
Panel C: Sort by Industry Percentage of Firms that are Rated				
Post Dummy	0.011	0.010***	-0.000	0.009**
	(0.007)	(0.004)	(0.003)	(0.005)
Treat. Dummy	-0.110***	-0.016***	0.024***	0.009
	(0.015)	(0.005)	(0.005)	(0.007)
Treatment*Post	-0.020*	-0.011**	0.002	-0.009
	(0.010)	(0.005)	(0.005)	(0.006)
R squared	0.322	0.337	0.113	0.159
Observations	4,802	4,768	4,804	4,768

Table A4. External finance dependence

This table examines the relationship between external finance dependence and liquidity management in relation to the GM-Ford crisis and the placebo crisis. Panel A is constructed as Table 2 (GM-Ford Crisis), while Panel B is constructed as Table 3 (Placebo Crisis).

	(1) Cash / (Cash + Credit Lines)	(2) Cash / Net Assets	(3) Undrawn Credit Lines/Net Assets	(4) Total Liquidity / Net Assets
Panel A: Sort by Industry Average External Finance Ratio				
Crisis Dummy	0.022**	-0.001	-0.010**	-0.011**
	(0.011)	(0.004)	(0.004)	(0.005)
Treat. Dummy	0.095***	0.020***	-0.018***	0.001
	(0.015)	(0.005)	(0.005)	(0.007)
Treatment*Crisis	-0.043***	-0.023***	0.010*	-0.012
	(0.013)	(0.006)	(0.005)	(0.008)
R squared	0.393	0.405	0.180	0.197
Observations	4,705	4,689	4,707	4,689

Panel B: Sort by Industry Average External Finance Ratio				
Crisis Dummy	-0.062***	0.010**	0.013***	0.023***
	(0.010)	(0.004)	(0.004)	(0.005)
Treat. Dummy	0.057***	0.018***	-0.012**	0.007
	(0.013)	(0.006)	(0.005)	(0.007)
Treatment*Crisis	0.013	-0.006	-0.007	-0.014*
	(0.013)	(0.006)	(0.004)	(0.007)
R squared	0.311	0.410	0.138	0.204
Observations	4,775	4,759	4,777	4,759

Table A5. Credit Line Usage across Top and Bottom Deciles and Terciles of Hedging Needs

This table provides two replicas of Panel A of Table 6 respectively using top and bottom deciles (Panel A), and top and bottom terciles (Panel B).

Panel A : Deciles	Variable: Mean (Median)			
	Presence of a Credit Line (Dummy)	Undrawn Credit / Net Assets	Undrawn Credit / Total Liquidity	Revolving Credit /Net Assets
Industry median Invest. Activities				
High hedging needs	0.621	0.088	0.305	0.029
N= 3037	(1.000)	(0.049)	(0.198)	(0.000)
Low hedging needs	0.858	0.135	0.532	0.037
N= 3104	(1.000)	(0.110)	(0.567)	(0.000)
t-test	21.930	15.433	27.042	4.172
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)
Industry median Tobin's Q				
High hedging needs	0.765	0.124	0.465	0.039
N= 2944	(1.000)	(0.091)	(0.490)	(0.000)
Low hedging needs	0.839	0.140	0.538	0.048
N= 3058	(1.000)	(0.118)	(0.595)	(0.000)
t-test	7.226	4.558	8.162	3.780
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)

Panel B: Terciles				
Industry median Invest. Activities				
High hedging needs	0.533	0.080	0.256	0.025
N= 11563	(1.000)	(0.014)	(0.049)	(0.000)
Low hedging needs	0.799	0.126	0.513	0.047
N= 11798	(1.000)	(0.101)	(0.568)	(0.000)
t-test	44.987	27.938	57.774	21.629
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)
Industry median Tobin's Q				
High hedging needs	0.625	0.097	0.316	0.029
N= 12701	(1.000)	(0.051)	(0.206)	(0.000)
Low hedging needs	0.691	0.111	0.426	0.046
N=12362	(1.000)	(0.080)	(0.437)	(0.000)
t-test	10.946	9.122	24.565	15.804
(p-value)	(0.000)	(0.000)	(0.000)	(0.000)

Description of Variables

Variable	*Construction*
Beta KMV	Firm's asset (unlevered) beta, calculated from equity (levered) betas and a Merton-KMV formula as in Acharya, Almeida and Campello (2010)
Book Leverage	Total Debt / Total Assets (6)
BV Equity	Total Assets (6) – Total Liabilities (181) – Deferred Taxes and Investment Tax Credit (35) – Preferred Stock
Capex/Assets	Capital Expenditures (128)/ Total Assets (6)
Cash Flow/Assets	(Operating Income Before Depreciation (13) – Interest Expense (15) – Income Taxes (16) – Dividends (21)) / Total Assets (6)
Cash Ratio	Cash and Short-Term Investments (1) / (Cash and Short-Term Investments (1) +(Undrawn) Credit Lines (CapitalIQ))
Cash/Net Assets	Cash and Short-Term Investments (1) / Net Assets
Cash/Net Assets (market value)	Cash and Short-Term Investments (1) / (Total Assets (6)- BV Equity + Market Value of Equity - Cash and Short-Term Investments (1))
Change in Working Capital	Yearly Change in Working Capital (179) – Yearly Change in Cash and Short-Term Investments (1)
CF Volatility	Standard Deviation of Operating Income Before Depreciation (13) over Previous 12 Quarters Scaled by Total Assets (6)
Covenant Index (Demiroglu and James (2010))	Sum of the following covenants: Collateral Release, Dividend Restrictions, Dummy Financial Covenants, Asset Sales Sweep, Equity Issuance Sweep, Debt Issuance Sweep. Where Dummy Financial Covenants equals one is at least two of the following covenants are included: Debt/Tangible Assets, Max Capex, Max Debt/Assets, Max Debt/Ebitda, Max Debt/Equity, Max Leverage, Max Senior Debt/Ebitda, Max Senior Leverage, Min Change Interest Coverage, Min Current Ratio, Min Debt Coverage, Min Ebitda, Min Equity/Asset, Min Fixed Charge, Min Interest Coverage, Min Net Worth/Assets, Min Quick Ratio, Net Worth, Other Ratio, Other, Tangible Net Worth.
Covenant Index (Drucker and Puri (2010)	Sum of following covenants: % Of Excess CF, % Of Net Income, Asset Sales Sweep, Collateral Release, Debt Issuance Sweep, Dividend Restrictions, Equity Issuance Sweep, Excess CF Sweep, Insurance Proceeds Sweep, Max Capex , Max Debt/Assets, Max Debt/Ebitda, Max Debt/Equity, Max Debt/Tangible Assets, Max Leverage, Max Senior Debt/Ebitda, Max Senior Leverage, Min Change Interest Coverage, Min Current Ratio, Min Debt Coverage, Min Ebitda, Min Equity/Asset, Min Fixed Charge, Min Interest Coverage, Min Net Worth/Assets, Min Quick Ratio, Net Worth, Other, Other Ratio, Tangible Net Worth.
Covenant Index (Only CF Covenants)	Sum of following covenants: % Of Excess CF, % Of Net Income, Excess CF Sweep, Max Capex, Max Debt/Ebitda, Max Senior Debt/Ebitda, Min Change Interest Coverage, Min Ebitda.
Covenant Index (Only Sweeps)	Sum of following covenants: Asset Sales Sweep, Debt Issuance Sweep, Equity Issuance Sweep, Excess CF Sweep, Insurance Proceeds Sweep.
Credit Lines/Net Assets	(Undrawn) Credit Lines (CapitalIQ)/ Net Assets
Credit Lines/Net Assets (market value)	(Undrawn) Credit Lines (CapitalIQ) / (Total Assets (6)- BV Equity + Market Value of Equity - Cash and Short-Term Investments (1))
Dividend Payer Dummy	A dummy variable that takes the value of one if common stock dividends (21) are positive, and zero otherwise
External Finance Ratio	Following Kaplan and Zingales (2005) external financing as the fraction of total financing is the ratio of net external financing to the sum of cash flow from operations (net income plus depreciation) and net external financing. Net external financing is the difference between net debt financing (debt issuances less debt reductions) and net equity financing (equity issuances less equity reductions taking minus dividends).
Full (Partial) Revocation of Credit Line (Dummy)	Takes value 1 in period t if a firm has available undrawn credit in t-1 and no available undrawn credit in t, and drawn credit has not increased between t-1 and t. Partial revocations are those in which undrawn credit availability decreases by 30% or more.
Hedging based on investment Activities	Correlation between three-digit annual mean industry investment activities adjusted for R&D expenses (item 311 + 46) and the annual mean industry cash flows measured as in Acharya, Almeida and Campello (2007). Three-digit mean industry investment activities are computed on the sample of unconstrained firms, defined as firms that pay dividends, have assets above $500m and rating above B+.
Hedging based on Tobin's Q	Correlation between three-digit median industry market-to-book and the firm-year cash flows measured as in Acharya, Almeida and Campello (2007). The three-digit mean industry market-to-book is computed on the sample of unconstrained firms, defined as firms that pay dividends, have assets above $500m and rating above B+.
Industry Mean Cash Ratio	Mean cash ratio at the two digit SIC code
M/B	(Market Value of Equity + Total Debt + Preferred Stock Liquidating Value (10) – Deferred Taxes and Investment Tax Credit (35)) / Total Assets (6)
Market Value of Equity	Stock Price (199) × Common Shares Used to Calculate EPS (54)
Net Assets	Assets (item 6) minus Cash and Short-Term Investments (1))
NWC/ Assets	(Working Capital (179) - Cash and Short-Term Investments (1))/ Total Assets (6)
Preferred Stock	Max[Preferred Stock Liquidating Value (10), Preferred Stock Redemption Value (56), Preferred Stock Carrying Value (130)]
Profitability	Operating Income Before Depreciation (13) / Total Assets (6)
R&D/Sales	Research and Development Expenses (46) / Sales (12)
Rated	A dummy variable that takes the value of one if the firm is rated by the S&P, and zero otherwise
Rating	Monthly S&P ratings (280). Takes 23 values: 1 = "AAA", 2="AA+", 3="AA", 4="AA-", 5="A+", 6="A", 7="A-", 8="BBB+", 9="BBB", 10="BBB-", 11="BB+", 12="BB", 13="BB-", 14="B+", 15="B", 16="B-", 17="CCC+", 18="CCC", 19="CCC-", 20="CC", 21="SD", 22="D", 23= Unrated
Revolving Credit / Net Assets	Revolving Credit (CapitalIQ)/ Net Assets

Size	Logarithm of Revenues (12)
Tangibility	Net Property, Plant, and Equipment (8) / Total Assets (6)
Total Debt	Debt in Current Liabilities (34) + Long-Term Debt (9)