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Liquidity mergers ☆

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ABSTRACT

We study the interplay between corporate liquidity and asset reallocation. Our model shows that financially distressed firms are acquired by liquid firms in their industries even in the absence of operational synergies. We call these transactions "liquidity mergers," since their purpose is to reallocate liquidity to firms that are otherwise inefficiently terminated. We show that liquidity mergers are more likely to occur when industry-level asset-specificity is high and firm-level asset-specificity is low. We analyze firms' liquidity policies as a function of real asset reallocation, examining the trade-offs between cash and credit lines. We verify the model's prediction that liquidity mergers are more likely to occur in industries in which assets are industry-specific, but transferable across firms. We also show that firms are more likely to use credit lines (relative to cash) in industries in which liquidity mergers are more frequent.

1. Introduction

Existing research argues investment funding is a key determinant of corporate liquidity policies (see, e.g., Opler, Pinkowitz, Stulz, and Williamson, 1999; Graham and Harvey, 2001; Almeida, Campello, and Weisbach, 2004; Denis and Sibilikov, 2010). Given that acquisitions are one of the most important forms of investment, one would expect that the benefits and costs of asset reallocation would be an important driver of liquidity. However, this notion has been largely overlooked by the literature on corporate liquidity.

In this paper, we propose and develop a theoretical link between corporate liquidity policies and asset reallocation opportunities. Our model explains why a distressed firm might be acquired by a liquid firm in its industry even when there are no true operational synergies between the firms.[1] We call this type of acquisition a *liquidity merger*. The model adds to our understanding of liquidity management by showing how credit lines might dominate alternatives such as cash and ex post financing in the funding of acquisitions. In particular, it shows that

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[1] By "lack of true operational synergies" we mean that a merger between the firms would not increase their combined value in the absence of financial distress. We do not imply that mergers do not generate operational synergies, but simply that they might occur even in the absence of such synergies. See Maksimovic and Phillips (2001) for evidence on productivity gains arising from mergers.

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credit lines can be a particularly attractive source of liquidity for high net worth, profitable firms.

The model's basic argument is as follows. Consider a firm that finds it difficult to raise credit because it cannot pledge its cash flows to investors. Limited pledgeability can arise from many sources, including moral hazard, asymmetric information, or private control benefits. In the model, firm insiders derive a non-pledgeable rent from their ability to manage assets that are industry-specific. If the firm is hit by a liquidity shock that is larger than its pledgeable value, the firm might not be able to raise the extra capital it needs even if continuation would be efficient. One option is to liquidate the distressed firm's assets at the value that can be captured by industry outsiders (sell for scrap). But if other industry players are able to operate the industry-specific assets (putting those assets to uses they were designed for), an acquisition by a healthy industry rival may dominate liquidation.[2] The problem with that alternative is that the acquirer itself may end up facing a similar pledgeability problem. In particular, outside investors (including those of the acquirer) might be unwilling to finance the merger since they can only capture the pledgeable portion of the gains associated with the deal.

How can the industry acquirer overcome this financing problem? To do this, the acquirer needs a source of funding that can be used at its discretion. The situation resembles the *ex ante liquidity insurance* problem of Holmstrom and Tirole (1997, 1998). In the Holmstrom-Tirole framework, the firm cannot wait to borrow after a large liquidity shock is realized because at that point external investors would be unwilling to provide funds. Instead, the firm needs to contract its financing ex ante. The optimal liquidity policy can be implemented either in terms of cash (the firm borrows more than its ex ante needs) or with an irrevocable line of credit. A similar logic follows through in the financing of a liquidity merger. The industry acquirer can overcome investors' unwillingness to finance the merger by accessing a discretionary form of financing that does not require investors' ex post approval. Liquidity mergers thus emerge as a link between firm financial policies and asset reallocation opportunities in an industry.[3]

Putting our theory in perspective, we model the link between mergers and liquidity policy by embedding the Holmstrom and Tirole (1997, 1998) liquidity demand model in an industry equilibrium framework that draws on Shleifer and Vishny (1992). Previous research suggests that a practical problem with lines of credit is that they may become unavailable precisely when the firm most needs them. However, the industry acquirer is most likely to demand liquidity for an acquisition in states in which it does not suffer a negative liquidity shock of its own. Hence, covenants that link line of credit availability to the firm's cash flow performance need not restrict the availability of financing to acquirers. We use this insight to show that lines of credit might dominate cash in financing liquidity-driven mergers, even when those credit facilities are revocable. In order to use cash to finance future acquisitions, the acquirer would need to carry large balances from the current period to all future states of the world. In the presence of a liquidity premium, this policy is costly. Given that cash flow-based covenants do not restrict the availability of merger financing under the credit line, cash becomes less desirable as the demand for merger financing increases.[4] The model analysis shows how merger activity may influence whether firms use cash or credit lines in their liquidity management. The analysis is novel, among other reasons, because it helps reconcile the observed positive correlation between a firm's profitability and its use of credit lines in lieu of cash for liquidity management (see Sufi, 2009; Campello, Graham, and Harvey, 2010).

Our model has several implications that have not yet been examined in the literature. First, it predicts that liquidity mergers should be more frequent in industries with high asset-specificity, but among firms whose assets are not too firm-specific. We identify these industries empirically based on two observations. First, we conjecture that *industry-specificity* is likely to be greater for assets such as machinery and equipment than for land and buildings. Accordingly, we use the ratio of machinery and equipment to total firm assets as a proxy for industry asset-specificity (machinery intensity). Second, we conjecture that *firm-specificity* should be inversely related to the degree of activity in asset resale markets in a firm's industry—the higher the use of second-hand capital amongst firms in an industry, the less firm-specific the capital. To construct a measure of "capital salability" within an industry, we hand-collect data for used and new capital acquisitions from the Bureau of Census' *Economic Census*. These data allow us to gauge asset salability through the ratio of used-to-total (i.e., used plus new) fixed capital expenditures by firms in an industry (cf. Almeida and Campello, 2007). Combining those two observations, we construct our desired measure as the product of "machinery intensity" and "capital salability." We call this composite proxy *Transferable assets.*

We then investigate if the ratio of liquidity mergers to the total number of mergers in an industry is related to asset-specificity (*Transferable assets*). Using a sample of 1,097 same-industry mergers drawn from the Securities Data Corporation (SDC) database between 1980 and 2006, we identify deals as potential liquidity mergers as those in which the target is arguably close to financial distress. Specifically, we attempt to isolate targets that have lower interest coverage than the average target, but at the same time have high profitability (to alleviate concerns that the

[2] Consistent with this notion, Ortiz-Molina and Phillips (2009) find that inside liquidity (provided by buyers inside the industry) reduces a firm's cost of capital by more than outside liquidity (provided by firms outside the industry).

[3] Industry peers are unique liquidity providers in the Holmstrom-Tirole setup because unlike industry outsiders (e.g., buyout groups), their management can capture non-pledgeable income associated with the assets of distressed targets.

[4] As we discuss below, the credit line reduces liquidity premia since it does not require the firm (nor the lender) to carry liquidity across time.

target firm may be economically distressed). Our tests include cross-industry regressions that control for characteristics such as industry-wide measures of financial distress, concentration, and capacity utilization. Consistent with our theory, we find evidence that the likelihood of liquidity mergers is higher when assets are both highly industry-specific and easily redeployable amongst industry rivals.[5]

In addition to our baseline test, we also examine the likelihood of same-industry acquisitions of distressed targets in the aftermath of a liquidity shock. To do this, we examine the collapse of the junk-bond market in the late 1980s. A number of developments taking place in 1989 effectively meant that junk-bond issuers lost access to liquidity coming from the corporate bond market—they experienced an exogenous shock to the supply of credit (see also Lemmon and Roberts, 2010). We study the patterns of liquidity-driven acquisitions involving the firms that were affected by this pointed liquidity shock. These additional tests confirm our model's prediction that, when faced with liquidity shocks, firms may engage in merger deals in which their assets are transferred towards other firms in their same industry depending on the level of asset-specificity.

The second model implication that we examine is that firms are more likely to use credit lines for liquidity management if industry asset-specificity is high, but firm asset-specificity is low (i.e., when *Transferable assets* is high). We use two alternative data sources to test this implication. Our first sample consists of a large data set of loan initiations drawn from Loan Pricing Corporation (LPC) DealScan over the 1987–2008 period. The LPC DealScan data have two potential drawbacks, nonetheless. First, they are largely based on syndicated loans, thus biased towards large deals (consequently, large firms). Second, they do not reveal the extent to which existing lines have been used (drawdowns). To overcome these issues, we also use an alternative sample that contains detailed information on the credit lines initiated and used by a random sample of 300 firms between 1996 and 2003. These data are drawn from Sufi (2009).

We measure the use of credit lines in corporate liquidity management by computing the ratio of available credit lines to available credit lines plus cash holdings. Our panel regressions show that firms are more likely to use credit lines in their liquidity management (relative to cash holdings) if they operate in industries with specific but transferable assets. This result is statistically and economically significant. For example, when using Sufi's (2009) sample, we find that a one-standard-deviation increase in *Transferable assets* increases the ratio of credit lines to total liquidity by 0.10, approximately 20% of the mean value of this ratio. This result is consistent with the model's implication that lines of credit are an attractive way to finance growth opportunities such as liquidity-driven acquisitions.[6]

Existing survey evidence suggests that lines of credit are not only used for liquidity management, but also to fund real operations (see Campello, Graham, and Harvey, 2010). Chief Financial Officers (CFOs) also indicate that credit lines are used to finance growth opportunities (such as acquisitions), while cash is used to withstand negative liquidity shocks (Lins, Servaes, and Tufano, 2010). To our knowledge, this is the first paper that theoretically reconciles real-world managers' view that cash and lines of credit are used for different purposes. A recent paper by Gabudean (2007) analyzes the interplay among rivals' cash policies in a Shleifer-Vishny (1992) industry equilibrium, but it does not examine liquidity mergers nor the trade-off between cash and credit lines. Asvanunt, Broadie, and Sundaresan (2011) show that cash holdings may be dominated by an adequately designed line of credit policy. Our paper, however, is the first to model the role of alternative liquidity instruments in the financing of acquisitions.[7]

Recent empirical papers examine the effect of excess cash on acquisitions (e.g., Harford, 1999; Dittmar and Mahrt-Smith, 2007; Harford, Mansi, and Maxwell, 2008). While their evidence also motivates our analysis, we focus on the opposite direction of causality. Namely, we model how the anticipation of acquisition opportunities affects corporate liquidity policy. In this sense, our paper is closer to Harford, Klasa, and Walcott (2009), who look at how deviations from target leverage affect whether acquisitions are financed with debt or equity. The key difference is that we focus on liquidity policy variables rather than leverage ratios. Our paper is also related to previous studies that analyze conglomerate mergers as a way of dealing with the target's inability to raise external funds (e.g., Hubbard and Palia, 1999; Fluck and Lynch, 1999; Inderst and Mueller, 2003).[8] One distinguishing feature of our merger model is that it pertains to within-industry acquisitions, as opposed to diversifying mergers. On a more theoretical level, we note that in prior models, mergers help mitigate the friction that generates the target's financial distress and increase the target's external financing capacity.[9] However, it is not the case that the acquirer directly supplies liquidity to the target as in our model, nor is there a clear role for the acquirer's liquidity policy.

The model we propose is novel in showing that acquirers from inside the industry are unique in turning around distressed assets. In particular, managers of rival firms are special in that their expertise allows them to extract asset-specific benefits from assets commonly used

[5] We also find that the fraction of liquidity-driven deals in our sample of *intra-industry* mergers is significantly higher than the fraction of liquidity-driven deals in a sample of *inter-industry* mergers. This finding supports our contention that industry firms are natural suppliers of liquidity for distressed rivals.

[6] We further discuss aggregate statistics and anecdotal evidence supporting our model's intuition that lines of credit are frequently used in the real world to finance liquidity mergers.

[7] Maksimovic (1990) shows that credit lines can boost a firm's competitive position in an imperfectly competitive industry, but the author does not analyze the trade-off between cash and credit lines.

[8] Maksimovic and Phillips (2002) consider an alternative neoclassical model of conglomerate mergers that rely on productivity gains rather than financing frictions.

[9] Stein (2003) calls this argument the "more money effect."

in their industry (transferable assets). Those agents may *both* gainfully operate distressed assets in the industry and bring to the table the funds needed to remedy liquidity shocks with funds that are made available immediately by virtue of precommitted financing arrangements. In this way, credit line-financed rivals have the necessary liquidity and ability to turn around distressed firms—they are unique in implementing a liquidity merger. Our model and empirics contribute to the literature by characterizing a situation in which liquidity constraints are resolved by a well-characterized combination of financial contracting and human capital expertise.

Finally, while the link between liquidity mergers and credit lines underlies our analysis, we stress that a central contribution of our work is to demonstrate the more general idea that credit lines are an effective way to transfer liquidity across states. Our point about credit lines is that they are a particularly effective way to finance investment opportunities that arrive in good states of the world, and for which the firm needs internal liquidity. While a "liquidity merger" strikes us as an interesting, practical example of such investments, it is certainly not the only one. Notably, however, it would be more difficult to test the model's predictions by looking at general investment items, such as capital expenditures. This is so because it is difficult to empirically isolate capital expenses that satisfy the model's conditions for a credit line to be an effective liquidity management tool (e.g., they need to arrive in good states of the world and strictly require internal liquidity). Similarly, the key economic insight behind the liquidity merger story is the advantage that the industry acquirer has in liquidity provision to distressed rivals. Whether the acquirer can supply liquidity to distressed firms depends on whether the acquirer has enough committed liquidity to draw on, and not on whether the liquidity comes strictly from credit lines.

In the next section we develop the benchmark model of liquidity demand and liquidity mergers. We do so under a security-design framework in which firms choose their optimal liquidity demand (at first) without any implementation constraints. The implementation of optimal liquidity using cash and credit lines is discussed in Section 3. Section 4 introduces a number of extensions to the basic model. Section 5 discusses the model's main empirical implications. The model's predictions are tested in Section 6. Section 7 concludes the paper. All proofs are placed in the Appendices.

2. A model of liquidity mergers and liquidity demand

We start from Holmstrom and Tirole's (1997, 1998) model of corporate liquidity demand, and embed the firm's liquidity optimization problem in an industry equilibrium that follows Shleifer and Vishny (1992). While these two theoretical pieces are well known, their insights have not been brought up together as a way to rationalize firm liquidity policy as a function of merger activity.

2.1. Basic framework

Consider an industry with two firms, which we call H and L.[10] There are three dates, and no discounting. Both firms have an investment opportunity of fixed size I at date 0. The firms differ according to their date-0 wealth, A. Firm H is a high wealth firm, so that $A_H > A_L$. The investment opportunity also requires an additional investment at date 1, of uncertain size. This additional investment represents the firms' liquidity need at date 1. We assume that the date-1 investment can be either equal to ρ, with probability λ, or zero, with probability $(1-\lambda)$. For now, we take that the investment need is independently and identically distributed (i.i.d.) across firms, that is, the probability that firm H draws ρ is independent of whether firm L draws ρ or zero. We refer to states using probabilities. So, for example, state λ^2 is the state in which both firms have date-1 investment needs. For convention, we let $\lambda(1-\lambda)$ be the state in which only firm H has a liquidity need for investment, and $(1-\lambda)\lambda$ be the state in which only firm L has a date-1 liquidity need.[11]

A firm will only continue its date-0 investment until date 2 if it can meet the date-1 liquidity need. If the firm continues, the investment produces a date-2 cash flow 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. If effort is low, the probability of success is lower, equal to p_B; however, managers consume a private benefit equal to B. Because of the private benefit, managers must keep a high enough stake in the project to induce effort. We assume that the investment is negative net present value (NPV) if the managers do not exert effort, implying the following incentive constraint:

$$p_G R_M \geq p_B R_M + B$$

or

$$R_M \geq \frac{B}{\Delta p}, \tag{1}$$

where 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. Following Holmstrom and Tirole (1997, 1998), we define

$$\rho_0 \equiv p_G\left(R-\frac{B}{\Delta p}\right) < \rho_1 \equiv p_G R. \tag{2}$$

The parameter ρ_0 represents the investment's pledgeable income, and ρ_1 its total expected payoff. Using moral hazard to generate limited pledgeability greatly improves the model's tractability. However, we stress that this

[10] In Section 4 we consider an extension in which there are many firms of each type.

[11] In Section 4 we consider, among other extensions, positively correlated investment needs and continuously distributed liquidity shocks.

interpretation does not need to be taken literally. For example, our model's central results would carry through if limited pledgeability was generated by information frictions between firm insiders and outside investors.

If the firm cannot meet the liquidity need, it is liquidated generating an exogenous payoff that does not rely on industry-specific managerial human capital (and thus is fully pledgeable to outside investors). We let this liquidation value be equal to $\tau < I$. In the current model, liquidation should be interpreted as the value of the firm's assets to an "outsider," that is, an investor who does not possess industry-specific human capital. The higher the τ, the lower is the industry-specificity of the firm's assets. We assume that the project is positive NPV, even if it needs to be liquidated in state $(1-\lambda)$:

$$U=(1-\lambda)\rho_1+\lambda\tau-I>0. \quad (3)$$

In lieu of liquidation, a firm that cannot meet its liquidity need can try to sell its assets to another firm in the industry. Since managers of other industry firms have industry-specific human capital, they may be able to generate higher value from the assets. However, because human capital may have a *firm-specific* component, industry managers are not perfect substitutes for each other. We assume that an industry manager can produce a cash flow $R-\delta/p_G$ by operating the assets of another industry firm.[12] The parameter δ captures the extent to which industry assets are firm-specific. For simplicity, we assume that the buyer of the assets always makes a take-it-or-leave-it offer to the distressed seller, meaning that the transaction price is always equal to the seller's outside option (τ).[13]

Fig. 1 shows the model's time line and summarizes the sequence of actions from the perspective of firm H. The figure also includes the realizations of liquidity shocks affecting firm L to show how the actions of firm H depend on whether firm L is in distress. To simplify the tree, we assume that firm H will only bid for firm L in the state in which firm H does not have to finance its own liquidity shock (i.e., state $(1-\lambda)$). As we show below, this is a natural outcome of the model. In addition, the tree incorporates the fact that managers must exert high effort on the equilibrium path and hence, the probability of success at date 2 is always equal to p_G.

2.1.1. Assumptions about pledgeability and net worth

We make the following assumptions about the model parameters:

$$\rho_0<\rho<\rho_1-\tau. \quad (4)$$

Given that a liquidity shock occurs, the net benefit of continuation is $\rho_1-\tau$. This assumption means that it is optimal for the firms to withstand the liquidity shock, but that date-1 pledgeable income is not sufficient to finance the shock. The model becomes trivial if this assumption does not hold, in that firms will generally not need liquidity insurance (if $\rho_0 \geq \rho$), or that it will never be optimal to survive a liquidity shock or to bid for the other industry firm (if $\rho \geq \rho_1-\tau$).

We make the following assumption about A_L:

$$\rho_0-\lambda\rho<I-A_L\leq(1-\lambda)\rho_0+\lambda\tau. \quad (5)$$

This implies that firm L does not have enough pledgeable income to be able to meet the liquidity need ρ in state λ. However, if firm L is liquidated in state λ, it generates total expected date-0 pledgeable income of $(1-\lambda)\rho_0+\lambda\tau$, which by (5) is larger than $I-A_L$. This assumption allows us to focus on the most interesting case in which firm L invests at date 0 and may become a target for firm H at date 1.

In this three-period model, the firm's "wealth level" A is a quantity that summarizes the firm's recent history, in particular the cumulative effects of past cash flow innovations. Assumption (5) captures the possibility that some industry firms may have, at some point in time, low enough accumulated wealth that they cannot fund future liquidity shocks on their own. Despite having low liquidity, firms of type L retain profitable investment opportunities. Specifically, condition (4) says that firm L's assets produce greater value under continuation $(\rho_1-\rho)$ than liquidation (τ). Thus, firm L faces the potential of financial distress if a liquidity shock hits at date 1.

We make the following assumption about A_H:

$$\rho_0-2\lambda\rho-\lambda[\tau-(\rho_0-\delta)]<I-A_H\leq\rho_0-\lambda\rho-(1-\lambda)\lambda[\rho+\tau-(\rho_0-\delta)]. \quad (6)$$

This assumption ensures that firm H has enough pledgeable income to withstand the liquidity shock and also bid for firm L in the case firm L is in distress. However, pledgeable income is enough to finance H's bid only in the event that H itself does not have a liquidity need in date 1. The role of this assumption will become clearer below. It captures the idea that firm H will be most likely to bid for L if its internal liquidity is high, which will happen in the case that H does not suffer a liquidity shock. Clearly, if firm H never has enough pledgeable income to bid for firm L, there will be no interactions among firms in the model.

2.1.2. External financing and liquidity insurance

Firms raise funds from external investors to finance the date-0 investment I, the date-1 investment ρ (when it is required), and also the bid for other industry firms that might become distressed. Throughout, we make the usual assumption that contracts are structured such that investors break even from the perspective of date 0.

In order to characterize the best possible financial contract that firms can get, we first take a security-design approach. Specifically, we assume that firms can write state-contingent contracts with external investors that specify the amount of payments that are made in each state of the world at date 1 and date 2. In Section 3, we will implement this optimal contract using real-world securities (such as cash and credit lines). This solution method helps highlight the trade-off between cash and

[12] The probability of success and the private benefit are assumed to be the same as in the original firm. Thus, the asset generates date-1 pledgeable income equal to $\rho_0-\delta$ if it is reallocated across firms.

[13] In Section 4 we discuss the more general case in which the seller also has some bargaining power.

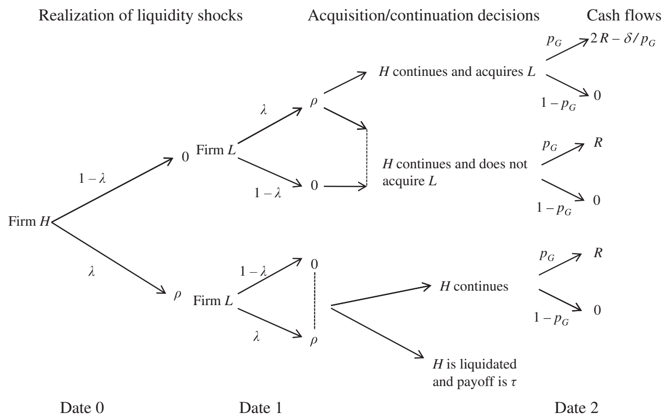

Fig. 1. Time line and sequence of actions from the perspective of firm H. It charts the acquidition/continuation decisions subsequent to possible realizations of liquidity shocks, which induce an additional investment ρ at date 1 with probability λ. Firm H (L) is the high (low) wealth firm at date 0, so that $A_H > A_L$. If a firm cannot meet the liquidity need ρ at date 1, it is liquidated at a price τ, which is less than the initial investment cost. If a firm continues until date-2, its investment produces a date-2 cash flow of either R or zero. If a firm's manager exerts high effort, the cash flow R obtains with probability p_G. In case of a intra-industry merger, an industry manager of H can produce a cash flow $R-\delta/p_G$ by operating the assets of industry firm L.

credit lines by comparing them against a benchmark of perfect state-contingent contracts.

In addition to date-1 payments, the optimal date-0 contract specifies the amount of external finance that firms raise at date 0, and the promised payment in case of success at date 2 (which happens with probability p_G). We denote the contractual amounts by $(K_0, K_{1,s}, K_{2,s})$, where s denotes the state of nature that realizes at date 1 (for example, $\lambda(1-\lambda)$).[14]

These contractual amounts must satisfy feasibility and pledgeability constraints. For each firm j, we must have that $K_0 \geq I - A_j$, so that firms have enough funds to start their projects. The constraints that $K_{1,s}$ must meet depend on the investment strategy that firms wish to implement at date 1. For example, in order for firms to withstand the liquidity shock in state λ, it must be the case that $K_{1,\lambda} \geq \rho$. For a firm to be able to bid for the other firm in state $(1-\lambda)\lambda$, we must have $K_{1,(1-\lambda)\lambda} \geq \rho+\tau$, so that the acquirer can cover the target's liquidity shock and liquidation option. The date-2 promised payments must obey the pledgeability constraints. In states in which a firm continues but does not acquire other assets, we must have $-K_{2,s} \leq R - B/\Delta p$ (or $-p_G K_{2,s} \leq \rho_0$). If a firm acquires the other one in state $(1-\lambda)\lambda$, we must have $-p_G K_{2,(1-\lambda)\lambda} \leq 2\rho_0 - \delta$. Finally, the payments $(K_0, K_{1,s}, K_{2,s})$ must be set such that investors break even from the perspective of date 0.

2.2. Equilibria

In equilibrium, firms choose their optimal investment and financing policies taking into account the optimal actions of the other firm. The model generates two different equilibria, depending on whether a liquidity merger is profitable or not. The liquidity merger is not profitable if

$$\rho_1 - \delta < \rho + \tau. \tag{7}$$

Firm H can generate a date-1 expected payoff of $\rho_1 - \delta$ by operating the assets of firm L. However, the merger requires firm H to cover L's liquidity shock and compensate L's investors, which involves an investment of $\rho+\tau$. By the same logic, the liquidity merger is profitable if[15]

$$\rho_1 - \delta \geq \rho + \tau. \tag{8}$$

We prove the following proposition in Appendix A:

Proposition 1. Under state-contingent contracting, the model generates the following equilibria:

- *If condition* (7) *holds, then the model's unique equilibrium is one in which firm L is liquidated in state* λ, *and continues its project otherwise. Firm H always continues, and there is no liquidity merger. These equilibrium strategies can be supported by the following state-contingent financial policies. For firm L*, $K_0^L = I - A_L$, $-K_{1,\lambda}^L = \tau$, $K_{1,(1-\lambda)}^L = 0$, *and* $-K_{2,(1-\lambda)}^L \leq \rho_0/p_G$, *such that investors break even at date*0. *For firm H*, $K_0^H = I - A_H$, $K_{1,\lambda}^H = \rho$, $K_{1,(1-\lambda)}^H = 0$, *and* $-K_2 \leq \rho_0/p_G$, *such that investors break even at date* 0.
- *If condition* (8) *holds, the model's unique equilibrium involves a liquidity merger in state* $(1-\lambda)\lambda$, *in which firm H acquires firm L. Firm L is liquidated in state* λ^2, *is acquired by firm H in state* $(1-\lambda)\lambda$, *and continues its project otherwise. Firm H always continues its project. Firm L's policy is identical to the one above. Firm H's policy is* $K_0^H = I - A_H$, $K_{1,\lambda}^H = \rho$, $K_{1,(1-\lambda)\lambda}^H = \rho+\tau$, $K_{1,(1-\lambda)^2}^H = 0$, $-K_{2,(1-\lambda)\lambda}^H \leq 2\rho_0 - \delta/p_G$, *and* $-K_{2,(1-\lambda)^2}^H =$

[14] Since firms produce zero cash flows in case of failure at date 2, the realization of uncertainty at date 2 is irrelevant. Firms promise payments out of date-2 cash flows, which are made only in the case of success.

[15] Under this condition, firm L's *fundamental value* (conditional on the liquidity shock) is $\rho_1 - \delta - \rho$. The assumption that firm H can make a take-it-or-leave-it offer to firm L ensures that H can purchase firm L at a price (τ) that is lower than the fundamental value. As we discuss later (see Section 4.5), the key assumption for the model's logic to go through is that firm L's price is lower than the fundamental value, though firm L can also capture part of the gains from the liquidity merger.

$-K^H_{2,\lambda} = -K^*_2 \le \rho_0/p_G$, *such that investors break even at date* 0.

It is interesting to discuss this result focusing on firm L first. By condition (5), firm L does not have enough pledgeable income to withstand the liquidity shock when it occurs at date 1. In addition, the assumption that firm H (the potential acquirer) has all the bargaining power in the event of a merger ensures that firm L's payoff is independent of firm H's policies (firm L's payoff is always equal to τ in state λ). Thus, firm L's policy is unchanged across the different equilibria. It simply entails borrowing enough funds to start the project, and then using pledgeable future cash flows to repay external investors.

Firm H's optimal policies, in turn, will depend on the level of industry- and firm-specificity. The equilibrium with no liquidity merger is more likely to hold when industry-specificity is low (τ is high), or firm-specificity is high (δ is low). In this equilibrium, firm H's optimal investment policy is to start its own project at date 0 and reinvest ρ in state λ at date 1 (so that it continues until the final date). In order to support this policy, firm H borrows sufficient funds to start the project at date 0 ($K^H_0 = I - A_H$) and receives an additional payment of ρ from external investors in state λ ($K^H_{1,\lambda} = \rho$). It promises a date-2 payment K_2 (in both states), so that investors break even.

If condition (8) holds, it becomes optimal for firm H to bid for firm L in state $(1-\lambda)\lambda$, provided that it has enough liquidity in that state. In addition, firm H must have enough liquidity to withstand its own liquidity shock in state λ. This equilibrium requires that $K^H_{1,\lambda} = \rho$ and $K^H_{1,(1-\lambda)\lambda} = \rho + \tau$. Notice also that since H is acquiring L, as long as $\rho_0 - \delta > 0$, its pledgeable income will increase in state $(1-\lambda)\lambda$. Thus, it can repay up to $2\rho_0 - \delta$ in that state. The assumption in Eq. (6) guarantees that H can finance both its own liquidity shock and the liquidity merger. Finally, Eq. (6) also implies that H cannot finance the liquidity merger in state λ^2 (when it needs to finance its own liquidity shock).

For future reference, the date-0 expected payoffs in the equilibrium with no liquidity merger are

$$U^N_H = (1-\lambda)\rho_1 + \lambda(\rho_1 - \rho) - I,$$

$$U_L = (1-\lambda)\rho_1 + \lambda\tau - I. \tag{9}$$

By conditions (3) and (4), both U^N_H and U_L are positive, so both firms invest at date 0.

The date-0 expected payoffs in the liquidity-merger equilibrium are

$$U^M_H = (1-\lambda)^2\rho_1 + (1-\lambda)\lambda(2\rho_1 - \rho - \delta - \tau) + \lambda(\rho_1 - \rho) - I,$$

$$U_L = (1-\lambda)\rho_1 + \lambda\tau - I. \tag{10}$$

Firm H's expected payoff is higher in Eq. (10) than in Eq. (9). This happens because H captures the gains from the merger. At the same time, L's expected payoff does not change.

It is important to stress that our model implies that industry counterparts are in a unique position to acquire and operate distressed assets because they can capture non-pledgeable income associated with those assets (non-pledgeable income is represented by $\rho_1 - \delta - \rho_0$ in the model above). Other pure-liquidity providers would not be able to extract the same private gains from the assets. Having a buyout group acquiring the firm and rehiring the manager would change the players, but not solve the problem since the maximum payoff of the acquisition for the buyout group in that case would be equal to ρ_0 (the firm's pledgeable income under the incumbent management, which is lower than the required investment $\rho + \tau$). A buyout group is similar to other liquidity providers in that they, too, would need to give the incumbent manager of the distressed firm a share of the surplus that pays for his private benefits (to keep incentives in line). Those benefits are associated with unpledgeable expertise. The only providers of liquidity that can take over distressed assets and extract asset-specific benefits are the managers of other similar firms. Our model is unique in characterizing this motivation for mergers.

Naturally, in order for a liquidity merger to be feasible, the acquirer (firm H) must be able to implement the state-contingent financial policy that is suggested by Proposition 1. We examine this issue in turn.

2.3. Main features of the optimal financial policy

Before implementing the financial policies that support each of the above equilibria, it is worth discussing their main features. In particular, while firm L's financial policy is simple (it involves only raising funds to finance the initial investment), firm H's financial policy involves state-contingent transfers from external investors to fund the liquidity shock and the bid for firm L.

The key economic feature of these transfers is that they must involve some degree of *precommitment* from external investors. Investors will generally not find it optimal to provide sufficient date-1 financing for the firm after the liquidity need is realized. In order to insure it has enough liquidity, firm H must gain access to a source of funds that does not require ex post approval from external investors in good states of the world.

To see this, consider first the equilibrium with no liquidity mergers. The optimal policy in Proposition 1 involves a liquidity infusion in state λ equal to $K^H_{1,\lambda} = \rho$. Notice that this infusion of cash is greater than the firm's pledgeable income in state λ, which is equal to ρ_0 (by condition (4)). Thus, the firm will only be able to withstand the liquidity shock if it can access a pre-contracted amount of financing greater than or equal to ρ. This financing can come, for example, from cash holdings (which the firm puts aside in date 0 and retains until date 1). Or it can come from a credit line. In either case, this liquidity injection generates a loss of $\rho - \rho_0$ for external investors. To compensate external investors for this loss, the optimal contract includes a net positive payment from the firm to investors in state $(1-\lambda)$, i.e., the state with no liquidity shock. If that state obtains, the firm receives zero transfers at date 1, $K^H_{1,(1-\lambda)} = 0$, but repays a positive amount to investors in date 2, $K^H_{2,(1-\lambda)} = K_2$. In other words, the optimal contract specifies a transfer of financing capacity from state $(1-\lambda)$, where it is not needed, to state λ, where it is crucial.

A similar intuition holds for the liquidity-merger equilibrium. The optimal policy involves liquidity transfers equal to $K^H_{1,\lambda}=\rho$ and $K^H_{1,(1-\lambda)\lambda}=\rho+\tau$. As in the other equilibrium, the firm needs precommitted financing in state λ to finance its own liquidity shock, since $\rho>\rho_0$. In state $(1-\lambda)\lambda$, the pledgeable income generated by the acquisition of firm L is equal to $\rho_0-\delta$. Clearly, this is lower than the investment that firm H needs to make in that state, which is equal to $\rho+\tau$. However, notice that firm H also has pledgeable income equal to ρ_0 in state $(1-\lambda)\lambda$, which it can use to fund the acquisition of firm L as well. This means that H needs precommitted financing to acquire L when

$$2\rho_0-\delta<\rho+\tau. \tag{11}$$

This is a sufficient condition for firm H to need precommitted financing.[16] If this inequality holds, the firm will need to transfer financing capacity into state $(1-\lambda)\lambda$. As in the analysis above, firm H compensates external investors for the provision of precommitted financing by making payments in states in which such financing is not needed. In particular, in the liquidity-merger equilibrium, the firm can pledge the cash flows that are produced in state $(1-\lambda)^2$, in which firm H never needs any liquidity (since neither firm is in distress). The optimal contract achieves this by letting $K^H_{1,(1-\lambda)^2}=0$ and $K^H_{2,(1-\lambda)^2}=K^*_2$.

Finally, notice that a financial contract that provides precommitted financing is a *liquidity insurance* mechanism for the firm. Essentially, the firm buys liquidity insurance (infusions of liquidity that generate ex post losses for external investors), by paying an "insurance premium" in the states of the world in which liquidity infusions are not needed. This liquidity insurance intuition will also be useful to understand some of the features of the implementation that we discuss below.

3. Implementation of the optimal financing policy

In Section 2 we assumed that the firms can perfectly contract on state-contingent financing, subject only to investor break-even and pledgeability constraints. In this section, we study the implementation of the equilibrium policies described above with real-world financial instruments.

As the discussion in Section 2.3 indicates, the optimal financing policy must involve some form of precommitted financing, or liquidity insurance. In the real world, there are two main instruments that firms use to insure their liquidity, namely, cash holdings and bank credit lines. Provided that cash holdings are under the control of the firm, cash is the simplest form of precommitted financing. Credit lines can also play the role of precommitted financing, provided that they can be made irrevocable (that is, the firm can draw on the credit line even when the bank is not properly compensated for the risk of the loan).

Other financing mechanisms, while important for the firm, may not satisfy this precommitted feature of the optimal contract. For example, a "debt capacity" strategy of carrying low debt into the future in the expectation that additional debt can be issued in the event of a liquidity shock may fail, because debt capacity will dry up precisely in times when the liquidity shock hits. For similar reasons, post-liquidity-shock equity issuance may fail to provide enough liquidity for the firm.

3.1. Buying liquidity insurance: cash and credit lines

Our main goal is to propose a trade-off between cash and credit lines and to show how this trade-off depends on the particular industry equilibrium predicted by the model. Before we do so, it is useful to understand intuitively how the firm can use cash and credit lines to replicate the financial policies specified in Proposition 1. Full implementation details will be provided in Section 3.2.

Besides cash and credit lines, to implement the optimal policy the firm will need to issue standard securities such as debt and equity. For concreteness, we will assume that the firm issues debt, even though the results are unchanged if we allow the firm to issue equity as well. In addition, we assume that if the firm issues debt at date 0, this debt is senior to any additional debt that the firm issues at date 1. While this is a realistic assumption, we also note that the results do not change if we allow the firm to violate priority at date 1.

We let D_0 represent the face value of the debt that firm H issues at date 0, and $D_{1,s}$ represent the face value of debt that firm H issues in state s at date 1. In case of success, the firm repays debt in date 2. For future reference, let D^*_0 represent the amount of date-0 debt that firm H needs to issue to be able to start its own project at date 0:

$$p_G D^*_0=I-A_H. \tag{12}$$

To implement the optimal policy using cash, the firm borrows more than D^*_0 (call this amount of debt D^C_0) and retains the extra funds in the balance sheet. The firm can then use cash to finance the date-1 liquidity shock and the bid for the other industry firm. Recall that external investors may be unwilling to contribute cash at date 1 due to limited pledgeability. Thus, the firm must be given the right to use cash balances at date 1, without requiring investor approval. Finally, the firm uses its excess liquidity (in states in which cash balances are not required at date 1) to ensure that external investors break even from the point of view of date 0.

To implement the optimal policy using a credit line, the firm does not need to borrow more than D^*_0 at the initial date. Instead, it enters a contract with date-0

[16] As we show in more detail below, whether this condition is also necessary depends on the details of the financial policy that implements the optimal contract characterized in this section. In particular, condition (11) is necessary only in the (extreme) case in which firm H is allowed to fully dilute the claims by date-0 external investors. For example, if firm H enters date 1 with some debt in its capital structure (issued at date 0), then condition (11) presumes that the firm can issue date-1 debt that is senior to the date-0 debt. Since this is unlikely to be true in reality, firm H is likely to require precommitted financing even when $2\rho_0-\delta>\rho+\tau$.

investors of the following form. It commits to make a payment equal to x at date 1 in exchange for the right to borrow an amount w that is lower than a prespecified amount equal to w_{max}, in case additional liquidity is needed at date 1. Provided that the date-0 investor cannot revoke the contract at date 1, this contract may allow the firm to borrow more than its pledgeable income at date 1. The firm compensates the date-0 investor for this right, by paying the "commitment fee" x in the states in which it does not need additional liquidity. Such a contract closely resembles a bank-provided credit line, which typically requires the firm to pay a fee to keep the line open in exchange for the right to borrow up to a prespecified amount (the size of the credit facility).

3.2. The trade-off between cash and credit lines

To clarify the trade-off between cash and credit lines, we start by assuming that the firm can only use one of the instruments in isolation. In Section 4.1 we allow the firm to use both instruments and show when the firm can benefit from using cash and lines of credit simultaneously.

3.2.1. Cash policy

As the discussion in Section 3.1 suggests, cash implementation requires the firm to carry cash balances across time. Existing evidence suggests that carrying cash is costly for the firm, for example, because of the existence of a liquidity premium. Consistent with this argument, most theoretical papers on cash policy assume a (deadweight) cost of carrying cash across time (see, e.g., Kim, Mauer, and Sherman, 1998; Almeida, Campello, and Weisbach, 2011). In our model, we capture the cost of carrying cash by assuming that the firm loses a fraction ξ of every dollar of cash that is carried across dates. For example, if the firm saves C dollars at date 0, then only $(1-\xi)C$ is available to finance investments at date 1.

To see how the cash implementation works, consider first the equilibrium without the liquidity merger. That is, assume that condition (7) holds. In this case, the optimal financial policy in state λ involves a transfer from investors of $K^H_{1,\lambda}=\rho$, which allows firm H to finance the liquidity shock. To implement this policy using cash, notice that for a given amount of debt D^C_0 issued at date 0, and given the seniority assumption, the firm has additional debt capacity equal to $\rho_0-p_G D^C_0$ at date 1. To survive the liquidity shock in state λ, the firm must thus save the following amount of cash:

$$(1-\xi)C+\rho_0-p_G D^C_0=\rho. \tag{13}$$

The firm raises the cash at date 0 by borrowing $I-A_H+C$, and returns cash to investors at date 1 in state $(1-\lambda)$. Because of the cost of carrying cash, the firm can only return $(1-\xi)C$ to investors in that state. Finally, the firm repays D^C_0 in case of success at date 2. The date-0 investor break-even constraint becomes

$$p_G D^C_0+(1-\lambda)(1-\xi)C=I-A_H+C. \tag{14}$$

Finally, the pledgeability constraint requires that $p_G D^C_0 \le \rho_0$.

As we show in Appendix B, if $\xi=0$, we obtain the same solution as in Proposition 1. As ξ increases, cash implementation may no longer be feasible.[17] Even if cash implementation is feasible, the cost of carrying cash implies a reduction in the firm's payoff. In the Appendix, we derive an exact solution for the optimal amount of cash C that the firm needs to hold if it does not need to finance the merger and the condition under which holding this cash level is feasible.

Let us consider now the liquidity-merger equilibrium. The crucial change in the optimal financial policy of Proposition 1 is that firm H must also finance the bid for firm L in state $(1-\lambda)\lambda$, that is, $K^H_{1,(1-\lambda)\lambda}=\rho+\tau$. If we let C^M denote the amount of cash that firm H must hold in the liquidity-merger equilibrium and D^M_0 the associated date-0 debt issuance, financing the liquidity-merger equilibrium with cash requires firm H to finance both its own liquidity shock and also the bid for firm L.

In the Appendix, we show that as long as the firm requires some amount of precommitted financing to fund the liquidity merger, it must save more cash in the liquidity-merger equilibrium ($C^M>C$). As discussed above (Eq. (11)), firm H may not need precommitted financing to finance the acquisition of firm L since it can use both its pledgeable income and the pledgeable income from the acquisition to finance the bid (a total of $2\rho_0-\delta$). In addition to the bid, the firm needs to repay date-0 debt. Therefore, it will need precommitted financing as long as:

$$2\rho_0-\delta-p_G D^C_0<\rho+\tau, \tag{15}$$

where D^C_0 is the amount of debt that allows the firm to carry cash balances equal to C (the minimum amount required to fund the liquidity shock). If condition (15) holds, the firm will need to use cash holdings to finance the liquidity merger and will return less cash to investors in state $(1-\lambda)$. Investors will then require additional compensation to finance the firm at date 0 (that is, $D^M_0>D^C_0$). Accordingly, the firm must save additional cash to survive the liquidity shock in state λ. In equilibrium, we must then have $C^M>C$ as well.

We summarize the results of this section in the following proposition (see proof in Appendix B):

Proposition 2. Let C represent the optimal cash balance in the case in which condition (7) holds, such that the liquidity merger is not profitable, and C^M represent the optimal cash balance when (8) holds, such that the liquidity merger is profitable. It follows that $C^M \ge C$, with strict inequality if condition (15) holds. In addition, let ξ^{max}_{NM} be the maximum cost of cash such that C is feasible, and ξ^{max}_M the maximum cost that allows C^M to be feasible. It follows that $\xi^{max}_{NM} \ge \xi^{max}_M$, with strict inequality if condition (15) holds. Finally, firm H's payoff is

$$U^{NC}_H=U^N_H-\xi C, \tag{16}$$

in the equilibrium with no liquidity mergers if $\xi \le \xi^{max}_{NM}$, and $U^{NC}_H=0$ if $\xi>\xi^{max}_{NM}$. In the equilibrium with liquidity mergers, the firm's payoff is

$$U^{MC}_H=U^M_H-\xi C^M \tag{17}$$

[17] That is, we may not find a value D^C_0 that satisfies both Eq. (14) and the condition that $p_G D^C_0 \le \rho_0$.

if $\xi \le \xi_M^{max}$, and $U_H^{MC}=0$ if $\xi > \xi_M^{max}$. U_H^N and U_H^M are given, respectively, by Eqs. (9) *and* (10).

3.2.2. Lines of credit

The advantage of a credit line relative to cash is that it does not require the firm to hoard internal liquidity. Under credit line implementation, the firm raises precommitted financing only in the states in which such financing is needed, conditional on the realization of the liquidity need. Thus, the credit line economizes on the liquidity cost ξ. For the firm, the cost of opening the credit line is that the firm must compensate the bank by making payments in states of the world in which the credit line is not used. As shown by Holmstrom and Tirole (1998) and Tirole (2006), the credit line can be structured as an "actuarially fair" contract, such that the expected payments from the firm to the bank are equal to zero. The main reason for this result is that credit line contracts allow the bank to operate as a "liquidity pool" that uses the payments coming from liquid firms to fund credit line drawdowns from firms that need additional liquidity.[18] In particular, since the bank can fund credit line drawdowns using payments from liquid firms, the bank does not need to carry liquid funds in its balance sheet over time. In Appendix D, we show that under the assumptions of our model, a financial intermediary such as a bank can indeed pool liquidity in an efficient way, and provide credit lines at an actuarially fair cost.[19]

The line of credit implementation relies on a commitment by the external investor (e.g., the bank) who provides the line to the firm. Existing empirical evidence, however, suggests that credit lines are not perfectly irrevocable. Sufi (2009) finds that if firms' cash flows deteriorate, the firm's access to credit lines is restricted through loan covenants. This result suggests that the firm might not be able to rely on credit lines to provide liquidity insurance in bad states of the world. In terms of our model, line of credit implementation is most likely to create problems in state λ, in which firm H is financially distressed. We capture this feature of credit lines by assuming that the outside investor denies financing in state λ with a probability equal to $q \le 1$.

While we take the probability q to be exogenous in the solution below, in the appendix we show that q can be endogenized in a framework in which the probability of the date-1's liquidity shock is affected by managerial effort (see Appendix D). In this framework, line of credit revocability gives incentives for the manager to try to avoid the occurrence of the liquidity shock.

To illustrate the credit line implementation, we proceed as above by analyzing the case of no liquidity mergers. Under credit line implementation, the firm does not need to borrow more than the minimum required to start the project at date 0 (call this debt level D_0^{LC}). If the credit line is revoked in state λ, the firm is liquidated, and thus the date-0 investor break-even constraint gives

$$(1-\lambda q)p_G D_0^{LC} + \lambda q \tau = I - A_H. \tag{18}$$

We denote the maximum size of the line in this equilibrium by w_{max}, and the commitment fee that the firm pays to the external investor by x. For the firm to survive the liquidity shock in state λ, the credit line must obey

$$w_{max} + \rho_0 - p_G D_0^{LC} \ge \rho. \tag{19}$$

This equation incorporates the firm's ability to issue new debt at date 1 up to the firm's date-1 pledgeable income ($\rho_0 - p_G D_0^{LC}$). In state $(1-\lambda)$, the firm does not use the credit line and pays the commitment fee x. The commitment fee is set such that the investor breaks even, given the amount by which the credit line is expected to be used (w_{max})[20]:

$$\lambda(1-q)w_{max} = (1-\lambda)x. \tag{20}$$

The credit line is feasible as long as the firm has enough pledgeable income to pay the commitment fee ($x \le \rho_0 - p_G D_0^{LC}$), which gives

$$I - A_H + \lambda(1-q)\rho \le (1-\lambda q)\rho_0 + \lambda q \tau. \tag{21}$$

Eq. (21) is implied by condition (6). That is, it is always feasible to use a line of credit to withstand the liquidity shock. Intuitively, the revocability of the line in state λ increases pledgeability, since the external investor does not benefit from continuation in that state. The main cost of the credit line comes from its revocability in state L. The firm's payoff becomes:

$$\begin{aligned} U_H^{NLC} &= (1-\lambda)\rho_1 + \lambda(1-q)(\rho_1-\rho) + \lambda q \tau - I \\ &= U_H^N - \lambda q(\rho_1 - \rho - \tau), \end{aligned} \tag{22}$$

where U_H^N is given by Eq. (9). The term $\lambda q(\rho_1-\rho-\tau)$ represents the expected loss from the revocability of the credit line.

Financing the liquidity merger with the credit line adds one constraint to the problem. In state $(1-\lambda)\lambda$, firm H must have enough liquidity to finance the bid for firm L. This requires:

$$w_{max}^{LC} + 2\rho_0 - p_G D_0^{LC} - \delta \ge \rho + \tau. \tag{23}$$

As we show in Appendix C, the firm chooses a credit line w_{max}^{LC} that is large enough to ensure that it has enough liquidity to finance both its own liquidity shock and also the liquidity merger. The firm finances the credit line by paying the commitment fee in the state in which the credit line is not used (state $(1-\lambda)^2$). As in the no-merger equilibrium, the main cost of the credit line is that it can

[18] Acharya, Almeida, and Campello (2010) show that exposure to aggregate liquidity risk places a limit on this pooling of liquidity needs, and increases the cost of credit lines for firms with high aggregate risk exposure. They show that aggregate risk may be an additional reason why firms use cash instead of credit lines to manage liquidity.

[19] In order to show this point (which is predicated on the existence of many firms that pool liquidity through the bank), we use an extension in which there are many firms of both types H and L. We note that the result is independent of the specific fraction of firms that is of each type.

[20] Notice that this particular formulation assumes that the credit line is paid only in state $(1-\lambda)$. This implies that the interest rate on the drawn portion of the credit line is zero. We note, however, that this formulation is not unique. It is straightforward (though notationally more cumbersome) to have a positive interest rate on the credit line.

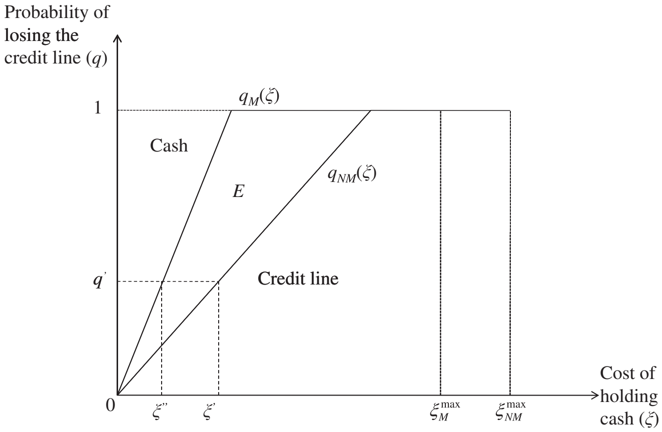

Fig. 2. Choice between cash and credit lines. It depicts the functions $q_{NM}(\xi)$ and $q_M(\xi)$ from Propositions 4 and 5, where q is the probability that the credit line is revoked after a liquidity shock and ξ is the cost of carrying cash across dates. For a pair (q,ξ) such that $q > q(\xi)$, firm H chooses cash rather than credit lines to implement the optimal liquidity policy. Similarly, for $q < q(\xi)$, firm H prefers credit lines to cash. The function $q_{NM}(\xi)$ depicts this threshold for the equilibrium without a liquidity merger, while the function $q_M(\xi)$ depicts this threshold for the equilibrium with a liquidity merger. The region E is the region in which firm H chooses cash if liquidity mergers are not profitable, but chooses a credit line if the liquidity merger becomes profitable.

be revoked in state λ. The firm's expected payoff becomes

$$U_H^{MLC} = U_H^M - \lambda q(\rho_1 - \rho - \tau), \tag{24}$$

where U_H^M is given by Eq. (10).

We summarize the results on the credit line implementation in the following proposition (see proof in Appendix C):

Proposition 3. It is always feasible to use a revocable line of credit to implement ex ante liquidity insurance. The amount by which firm H's payoff is reduced (the expected loss from the revocability of the credit line, $\lambda q(\rho_1 - \rho - \tau)$), is the same both when condition (7) holds, such that the liquidity merger is not profitable, and when (8) holds, such that the liquidity merger is profitable.

3.2.3. Choosing between cash and lines of credit

The firm's choice between cash and credit lines depends on the relative size of the parameters q and ξ. The main cost of the credit line is the possibility that the line might be revoked in the bad state of the world, which happens with probability q. While cash holdings can avoid this problem, they require internal liquidity hoarding whose cost is captured by the parameter ξ. Starting with the equilibrium with no liquidity mergers, we can show the following intuitive result (see proof in Appendix E):

Proposition 4. Suppose condition (7) holds, such that the liquidity merger is not profitable. There exists a function $q_{NM}(\xi)$, satisfying $q'_{NM}(\xi) \geq 0$ and $q_{NM}(0) = 0$, such that if $q > q_{NM}(\xi)$, the firm prefers cash to lines of credit, and if $q < q_{NM}(\xi)$, the firm prefers lines of credit to cash.

Fig. 2 depicts the function $q_{NM}(\xi)$, and the associated regions in which the firm prefers cash or credit lines.

We can now state one of the main results of the paper (see proof in Appendix F):

Proposition 5. Suppose condition (8) holds, such that the liquidity merger is profitable. There exists a function $q_M(\xi)$, satisfying $q'_M(\xi) \geq 0$ and $q_M(0) = 0$, such that: (i) if $q > q_M(\xi)$, the firm prefers cash to lines of credit and if $q < q_M(\xi)$, the firm prefers lines of credit to cash; and (ii) $q_M(\xi) \geq q_{NM}(\xi)$. In other words, the firm is more likely to use lines of credit in the liquidity-merger equilibrium.

Fig. 2 depicts $q_M(\xi)$, showing the region under which cash dominates the credit line. This region shrinks as we move from the equilibrium with no mergers to the equilibrium with mergers. In Fig. 2, the triangle marked as E depicts the parameter region in which the firm would choose cash if it does not need to finance a liquidity merger, but a line of credit if there is a need to finance the merger.

This result shows that firms are more likely to use lines of credit in the liquidity-merger equilibrium. The intuition can be stated as follows. The cost of implementing the optimal liquidity policy with cash holdings is higher in the equilibrium with liquidity mergers, since firm H must carry more cash in that equilibrium ($C^M > C$). The higher required cash balance reduces the firm's payoff and tightens the feasibility constraint. In contrast, the cost of using a line of credit is the same in the two equilibria, given that the expected loss from the revocability of the credit line is the same (Proposition 3). Intuitively, since the increase in liquidity needs is concentrated in good states of nature (those in which the firm needs to finance a liquidity merger), the revocability of the credit line does not play a role.[21] This makes the line of credit a preferred liquidity instrument in the liquidity-merger equilibrium.

4. Extensions

In this section we discuss the role of some of the assumptions that we have made for model tractability. In some cases, our motivation is to discuss the robustness of

[21] In addition, the firm (and the bank, in equilibrium, as show in Appendix I), has enough pledgeable income to fund this increase in credit line demand without increasing the cost of the line.

the model's results. In others, extending the analysis motivates additional implications discussed in Section 5.

4.1. Combining cash and lines of credit

The analysis above assumes that the firm can use either cash or credit lines to implement ex ante liquidity insurance, but not both. Can the firm benefit from having both cash and a credit line at the same time?

The first point to note is that such a policy can only benefit the firm in the liquidity-merger equilibrium. Suppose condition (7) holds, such that the liquidity merger is not profitable. If $q<q_{NM}(\xi)$, the firm prefers lines of credit to cash, despite the excessive liquidation in state λ. However, it is not profitable for the firm to use cash to decrease the expected loss from revocability, since this would require the firm to hold an amount of cash equal to C (the same amount that it needs to hold if it chooses only cash to implement liquidity insurance). Similarly, if $q>q_{NM}(\xi)$, the firm uses cash and there is no additional benefit to opening a credit line since the firm is never liquidated in state λ.

If, in contrast, the firm must finance both the liquidity shock and the merger, then there can be a role for a simultaneous cash/credit line policy. For example, consider the region in which $q<q_M(\xi)$, such that the firm prefers lines of credit to cash. If it is feasible for the firm to save enough cash to finance the liquidity shock in state λ, then it might be optimal for the firm to have both cash and a credit line. We analyze this case in Appendix G. Importantly, we show that allowing for the possibility of a joint policy *does not change* the conclusion that the firm is more likely to use lines of credit in the liquidity-merger equilibrium. This implication could become ambiguous if the joint policy reduced the parameter region in which the firm uses credit lines in the liquidity-merger equilibrium, relative to the equilibrium with no mergers (the region in which $q<q_{NM}(\xi)$). At the same time, we show that the joint policy cannot be optimal if $q<q_{NM}(\xi)$, even in the equilibrium with liquidity mergers.

4.2. Continuum of liquidity shocks

We assumed for simplicity that the liquidity shock had a binomial distribution with mass at ρ and zero. In this case, the model's logic requires firm L not to have any liquidity insurance. If firm L had enough liquidity to pay for ρ, there would be no liquidity mergers. And if L cannot pay for ρ, there is no point in saving any liquidity.

We note that this stark solution is due to the specific binomial assumption that we used. For example, we could alternatively assume that the liquidity shock ρ is distributed in a range $[0,\rho^{max}]$. In this case, a firm's optimal liquidity policy states the maximum level of the shock that it can withstand. That is, a firm i saves enough liquidity to withstand shocks below a certain cutoff ρ_i, where $i=L,H$ (see Tirole, 2006). The optimal solution would then have $\rho_L \le \rho_H$, given H's higher wealth A_H. Thus, firm H would be able to withstand a greater range of liquidity shocks, and firm L would also save some liquidity in equilibrium.

Importantly, it would still be the case that firm H would be the natural acquirer in a liquidity-merger equilibrium. Its higher initial wealth makes it easier for H to save enough liquidity to bid for L. Notice also that, since $\rho_L \le \rho_H$, firm L is more likely to be financially distressed in equilibrium, increasing the benefit of liquidity hoarding for firm H. Finally, if firm L is to save liquidity, its priority would be to survive its liquidity shock rather than being able to bid for the other firm (which yields a lower payoff due to firm-specificity).

This analysis suggests the following conjecture. Since firm L is unlikely to save liquidity for a future bid, relative to firm H it is less likely to demand a line of credit (which is particularly beneficial for the financing of the merger). While the model above also delivers this implication, it may seem trivial since firm L does not demand any liquidity (including cash). The analysis here suggests that if firm L is to demand liquidity, its main goal would be to finance its liquidity shock rather than an acquisition. Relative to firm H, firm L would be less likely to demand a credit line.

4.3. Correlation between liquidity shocks

We assumed that the liquidity shocks were uncorrelated across the two firms in the industry. This assumption raises the incidence of liquidity mergers in the model, since it increases the probability of the state in which only one of the industry firms has a liquidity shock. If both firms suffer a liquidity shock, then the liquidity merger is less likely since the industry acquirer becomes more financially constrained.[22] However, we note that the model is qualitatively identical if the correlation is positive, as long as the correlation is less than one. Nothing changes in the model if liquidity mergers are not profitable, since in this case there is no interaction among firms. If liquidity mergers are profitable, they are still most likely to happen (1) in the states of the world in which only some industry firms are financially distressed, (2) among firms with industry-but-not-firm-specific assets, and (3) to be financed by lines of credit.

In addition, recall that we assumed that firm H did not have enough pledgeable income to bid for firm L if both firms are hit with liquidity shocks. If this assumption is relaxed, liquidity mergers would happen even in states of the world in which the entire industry suffers a liquidity shock. One interesting possibility is that in this case, the role for joint cash and credit line policies (as discussed in Section 4.1) should increase, since firm H needs to finance both its own liquidity shock and the bid for firm L. We conclude that allowing for a positive correlation between liquidity shocks would make liquidity mergers less common, and possibly more costly to finance. But the main conclusions of the model would remain the same.

[22] See Pulvino (1998) for evidence that financial constraints increase the likelihood of asset sales to industry outsiders, particularly in market downturns when industry insiders are less likely to be viable acquirers.

4.4. Aggregate shocks to pledgeability

We assumed that pledgeability of future cash flows (captured by the parameter ρ_0) is unchanged across different states of the world in date 1. However, if a firm enters financial distress in times in which aggregate liquidity is low, it might be more difficult for the firm to raise external financing. This effect would be at play, for example, if there was an aggregate shock that reduced ρ_0 while at the same time increasing the liquidity shock ρ for all industry firms.

A correlation between ρ and ρ_0 may increase the role for liquidity mergers and liquidity insurance. Notice that the firm's internal liquidity sources (such as cash holdings and outstanding lines of credit) are not necessarily affected by the pledgeability shock, since they offer precommitted sources of financing. It is interesting to note that there is debate about whether banks renege on their loan commitments. In the real world, virtually all credit lines have a covenant that gives the bank the right to revoke the credit facility (the "materially adverse conditions"). Thakor (2005), however, provides a theory explaining why banks avoid evoking these clauses too often. By most accounts, the recent financial crisis is seen as an episode where pledgeability was negatively shocked. At the same time, the existing evidence suggests that banks have largely honored their pre-crisis line of credit agreements (see Ivashina and Scharfstein, 2010; Campello, Graham, and Harvey, 2010).

Thus, the advantage of a liquid industry firm over an outsider can increase in times of aggregate liquidity shocks. This analysis suggests that if the correlation among industry firms' liquidity shocks is caused by an aggregate shock that also affects pledgeability, then the negative effect of correlation on liquidity mergers is mitigated. While within-industry correlation hinders liquidity mergers, economy-wide liquidity shocks can increase the incidence of liquidity mergers.

4.5. Bargaining power

We assumed that in the event of a merger, the acquirer (firm *H*) makes a take-it-or-leave-it offer to firm *L* and thus captures the entire rent from the liquidity merger. Clearly, the model's logic requires that firm *H* has some bargaining power in the event of a merger, or else firm *H* will not have incentives to alter its liquidity policy in the anticipation of a future acquisition opportunity. However, as long as firm *H* retains some bargaining power, the model is qualitatively identical.

Given the model's assumptions, firm *L* would not have incentives to change its liquidity policy in the event that it captures a fraction of the rents. Since this reduces the costs of financial distress for firm *L*, its incentives to manage liquidity are even lower in this case. If firm *L* also has an active liquidity management policy (see, e.g., Section 4.2), then more interesting interactions can arise. For example, *L*'s incentives to save cash to withstand the liquidity shock would generally decrease as it captures a greater fraction of the rent. This effect can also change *H*'s liquidity policy, since it affects the probability that firm *L* is distressed and that a liquidity merger might occur. Our model's main conclusions, however, would still carry through.

4.6. Multi-firm setting

The industry in our benchmark model is composed of one firm of each type (*L* and *H*). In this simplified structure, firm *H* can acquire firm *L* whenever *H* has enough liquidity, and *L* faces a liquidity shock (state $(1-\lambda)\lambda$). One concern is whether the model's results generalize to a multi-firm setting, in which the probability of a liquidity merger can depend on the number of potential targets and acquirers. This section extends our analysis to an industry with multiple firms of both types.

We assume that the fraction of high wealth firms (*H* firms) in the population is given by the parameter μ. We maintain the model's assumptions about pledgeability and net worth (assumptions (4)–(6)). Under the assumption of idiosyncratic liquidity shocks, there will now be $\mu(1-\lambda)$ firms of type *H* that do not have a liquidity shock (the potential acquirers), and $(1-\mu)\lambda$ firms of type *L* that have a liquidity shock and need a liquidity infusion.

We assume that the number of potential acquirers is significantly greater than the number of distressed firms that require a liquidity infusion. Specifically, we have

$$(1-\mu) < \mu(1-\lambda). \tag{25}$$

This condition captures the notion that the probability of true financial distress is likely to be low, and thus the number of potential targets should not be too high. Notice that this condition will be obeyed when μ (the fraction of firms of type *H*) is large, and/or λ (the probability of a liquidity shock) is small.

We also assume that firms that are in need of a liquidity infusion (there are $(1-\mu)\lambda$ of those) are randomly assigned to the $\mu(1-\lambda)$ potential acquirers. Accordingly, the probability that a potential acquirer finds a liquidity merger opportunity is given by $((1-\mu)/\mu(1-\lambda))\lambda$. Recall that in the two-firm version, if firm *H* does not have to finance a liquidity shock (state $1-\lambda$), the probability of a liquidity merger is equal to λ (the probability that firm *L* has a liquidity shock). Thus, by condition (25), the probability of a liquidity merger will go down in the multiple-firm version of the model.

Finally, we assume that firms of type *H* continue to capture the entire rent from liquidity mergers. This may seem a strong assumption given that there is an excess demand for liquidity-driven acquisitions. However, notice that any equilibrium of the model will require firms of type *H* to capture some of the rents from mergers. In order to see this point, suppose that there was an equilibrium in which *L* firms captured all the rents (because there are too many *H* firms bidding for them). In this case, *H* firms would not have the ex ante incentive to build the liquidity that is required to finance liquidity mergers. But if those firms do not have liquidity, they cannot compete for mergers, decreasing the competition for targets. Thus, an equilibrium with no rent for acquirers cannot exist. As long as *H* firms continue to capture some of the rents, the model would be qualitatively identical (as we discuss in

Section 4.5). This last assumption is used to facilitate the model's solution (it does not alter the model's economic intuition).

Under this set of assumptions, the solution is essentially identical to that described in our base model, with the key difference being that from the perspective of each firm of type *H*, the probability of a liquidity merger decreases from $(1-\lambda)\lambda$ to $(1-\lambda)\lambda(1-\mu)/\mu(1-\lambda)$. Indeed, if we define λ' as

$$\lambda' \equiv \lambda \frac{(1-\mu)}{\mu(1-\lambda)} < \lambda, \tag{26}$$

the analysis of the model is identical to that presented above, if we replace the parameter λ with λ'.

In terms of the model's results, the main difference is that credit lines become less desirable relative to cash holdings in this multi-firm setting. The intuition for this result (which we show in Appendix H) is as follows. First, given that the probability of a liquidity merger goes down, the amount of cash that the firm needs to save to fulfill its liquidity needs decreases. Second, while the demand for the credit line also goes down, this decline does not benefit the firm as much as the decline in cash holdings. The main cost of credit lines is that they may be revoked in the bad state of nature. However, this cost is independent of the probability of a liquidity merger (which happens when firm *H* is in a good state of nature). It follows that firms are more likely to choose cash over credit lines in the model with multiple firms, because the probability of a liquidity-driven acquisition declines.

Finally, notice that despite the decline in the desirability of credit lines, the model's predictions are qualitatively unaffected by the probability of liquidity mergers (as we also show in the appendix). In particular, it is still the case that credit lines are more likely to be used in industries in which liquidity mergers are more prevalent.

5. Model implications

Our model yields multiple implications. Some of these implications are supported by the available empirical evidence. Others have not yet been documented and are tested later in the paper. This section revisits the model, highlighting and recasting the most interesting testable hypotheses coming out of the analysis.

For ease of reference, we list the main implications of our model:

Implication 1. Liquidity mergers are more likely to occur in industries with high asset-specificity, but among firms whose assets are not too firm-specific.

This result follows directly from Proposition 1. Notice that this result is independent of how the liquidity merger is financed (ex post issuance, cash, or lines of credit). The key economic insight that drives this result is that the industry acquirer has an advantage in liquidity provision to the distressed firm because of industry-specificity. If the acquirer has enough liquidity to draw on, the merger becomes feasible.

How to identify a "liquidity merger" in the data? The model suggests that it is a merger that might not necessarily happen in the absence of liquidity shocks, but is due to distress in one of the firms in an industry and the advantage another firm has in managing industry-specific assets. Thus, mergers and acquisitions of a distressed target by another firm in the same industry are potential candidates. Clearly, the liquidity merger can only happen if firm-level asset-specificity is not too high. In the next section, we experiment with an identification exercise of this type in order to guide our empirical work.

Given that the purpose of liquidity reallocation in our model is to overcome the inability of the target to raise external funding, one might wonder why we are focusing specifically on financially *distressed* targets, as opposed to targets that are financially *constrained* in a broader sense.[23] The answer is that a target that is constrained but not distressed does not necessarily face the choice between liquidation and asset sale that we model in the paper. Such a target also has the option to withstand a liquidity shock by investing less than what would be optimal in the absence of the shock, and waiting for the access to external capital to improve. Given that asset reallocations impose costs due to firm-specificity, this option should be attractive for a constrained target.

Another key result of the model comes from Proposition 5:

Implication 2. If industry asset-specificity is high and firm asset-specificity is low, then firms are more likely to use lines of credit in their liquidity management.

This result follows from the insight that the line of credit is a particularly attractive way of financing growth opportunities that arrive in good states of nature, but that may require liquidity insurance. A liquidity-driven acquisition is an example of such an investment.[24]

Section 4 also suggests the following implication:

Implication 3. Liquidity mergers are more likely to occur when there is low correlation between the liquidity needs of firms in the industry.

Naturally, measuring this correlation in the data can be challenging. One option is to use a firm's observed external financing needs (e.g., investments minus internal funds) as a proxy for firm-level liquidity needs (see Acharya, Almeida, and Campello, 2007 for an empirical proxy). Clearly, the correlation that matters for the model's results is that among firms in the same industry.

The implications above work mostly at the level of the industry. In addition, the model has the following firm-level implication:

[23] See Almeida, Campello, and Weisbach (2011) for a discussion of the differences between financial distress and financial constraints.

[24] This implication does not imply that liquidity mergers are financed exclusively through credit lines. In the model, the firm also issues debt to finance liquidity mergers, and may also use cash jointly with credit lines (see Section 4.1). The point is that credit lines are *more likely* to be used in industries in which liquidity mergers are more prevalent.

Implication 4. Within an industry, "*deep-pocket*" *firms are more likely to use lines of credit in their liquidity management*.

In the model, the firm with high initial wealth (firm H) is more likely to use credit lines than firm L, the firm with low initial wealth. As we discuss in Section 4.2, if firm L is to demand liquidity insurance, its main priority is to finance its own liquidity needs, rather than bids for other industry firms. Thus, relative to firm H, firm L is less likely to demand credit lines (and more likely to use cash).

In order to operationalize this result, notice that the firm's initial wealth A can be broadly interpreted as the stock of internal funds that the firm can draw on to decrease its external financing needs. Empirically, A should be correlated with variables such as the firm's profitability and its stock of retained earnings. Thus, this result can help explain the empirical observation that profitable firms are more likely to use credit lines in their liquidity management (as reported in Sufi, 2009).[25] In addition, we note that one should be careful when using stock variables (such as retained earnings and net worth) to proxy for A, since these stock variables are partly the result of the firm's optimal policies. For example, Sufi finds that net worth (defined as book equity minus cash scaled by assets minus cash) is negatively correlated with the use of credit lines. One simple explanation for this correlation is that firms that use credit lines will also have higher debt (given that credit line debt is recorded as debt in Compustat) and thus lower book equity.

6. Empirical evidence

This section reports tests that focus on the industry-level implications of our model. In particular, we examine the model's predictions related to liquidity-driven acquisitions and to the use of lines of credit that back acquisitions. We first describe the sample construction of mergers and lines of credit. Then, we introduce our proxies for firm asset-specificity, industry asset-specificity, liquidity mergers, and line of credit usage. Finally, we document the incidence of liquidity mergers across industries, the relation between firm/industry asset-specificity and liquidity mergers, and the relation between firm/industry asset-specificity and the use of lines of credit in corporate liquidity management.

6.1. Data description

Our sample of mergers and acquisitions is drawn from the Securities Data Corporation's (SDC) U.S. Mergers and Acquisitions Database. We obtain accounting and financial data on acquirers and targets from Compustat. We gather data on domestic mergers and acquisitions with announcement dates between January 1, 1980 and December 31, 2006. Our sample selection process follows the literature requiring that: (1) the transaction is completed; (2) the number of days between the announcement and completion dates is between zero and 1,000; (3) the target is a firm with accounting data on Compustat or SDC during the time of the takeover; (4) the deal value is greater than \$1 million; (5) the acquiring firm controls less than 50% of the shares of the target firm before the announcement; (6) the acquiring firm ends up with all the shares of the acquired firm; and (7) the acquirer and the target operate in the same industry, defined by three-digit Standard Industrial Classification (SIC) codes. Due to the need to construct our proxy for liquidity mergers, we drop all targets that have missing data on interest coverage or negative interest coverage. The latter cutoff is due to the fact that such targets are likely to be in economic, rather than financial distress. We end up with a sample of 1,097 transactions.

We use two alternative sources to construct our line of credit data. Our first sample (which we call *LPC sample*) is drawn from LPC DealScan. These data allow us to construct a large sample of credit line initiations, observing the purpose of each facility. As we explain below, when using these data, we keep in the sample only those credit lines which are likely to be used to finance investment and we drop credit agreements that do not correspond to the credit lines characterized by our theory (for example, those that are used as back-ups to commercial paper). We note, however, that the LPC DealScan data have two potential drawbacks. First, they are mostly based on syndicated loans, thus potentially biased towards large deals and consequently towards large firms. Second, they do not allow us to measure line of drawdowns (the fraction of existing lines that has been used in the past). To overcome these issues, we also study an alternative sample that contains detailed information on the credit lines initiated and used by a random sample of 300 Compustat firms between 1996 and 2003. These data are provided by Amir Sufi on his Web site and were used in Sufi (2009). We denote these data *Random sample*. Using these data reduces the sample size for our tests and does not allow us to measure the purpose of the credit line. We regard these two samples as providing complementary information on the usage of credit lines for the purposes of this paper.

To construct the *LPC sample*, we start from a sample of loans in LPC DealScan in the period of 1987–2008 for which we can obtain the firm identifier *gvkey* (which we later use to match to Compustat).[26] We drop utilities, quasi-public, and financial firms from the sample. We consider only short-term and long-term credit lines, which are defined as those that have the LPC field "*loantype*" equal to "364-*day facility*," "*revolver/line* <1 *yr*," *revolver/line* $>=1$ *yr*," or "*revolver/line*." In our tests, we keep only the credit lines which are likely to be used for the financing of future investments, namely those whose purpose is labeled "*acquisition line*," "*capital expenditures*," "*corporate purposes*," or "*takeover*."

Our unit of observation for the *LPC sample* is a firm-quarter. In some cases, the same firm has more than one credit line initiation in the same quarter. In these cases,

[25] See also the empirical results below, in particular Tables 7 and 8.

[26] We use several procedures to obtain *gvkeys*, including a file provided by Michael Roberts, which was used in Chava and Roberts (2008), firm tickers (which are available from LPC), and manual matching using firm names.

we sum the facility amounts (the total available credit in each line) for each firm-quarter and average the other variables using the facility amount as weights. We let $AcqLC_{i,t}$ denote the total value of future investment- (acquisition-) related credit lines initiated in quarter t by firm i, and let $Maturity_{i,t}$ denote the average maturity of these lines (in quarters).[27]

To construct the *Random sample*, we start from the "random sample" used in Sufi (2009), which contains 1,908 firm-years (300 firms) between 1996 and 2003. Sufi's data set includes information on the total credit line facilities available to firm j in year t (denoted $Total\ line_{j,t}$), and the amount of credit in these lines that is still available to firm j in year t ($Unused\ line_{j,t}$). We use this information to construct our proxies for credit line usage (described below).

6.2. Proxy variables

6.2.1. Identifying liquidity mergers

To identify liquidity-driven acquisitions, we need to stratify the sample according to a measure of financial (not economic) distress. Following Asquith, Gertner, and Scharfstein (1994) and Andrade and Kaplan (1998), we employ interest coverage ratios as a measure of financial distress.[28] To identify transactions in which a plausibly economically viable target is close to financial distress, we require that the target firm has (1) an interest coverage ratio below the median interest coverage ratio in Compustat for our sample period, and (2) profitability above the median profitability in Compustat. We call this classification scheme "Definition A." This basic definition identifies targets that are likely to be financially but not economically distressed, while maintaining a large enough sample of potential liquidity mergers. However, this classification likely captures targets that are not truly distressed. To refine this definition, we also consider a classification scheme that requires the target to have (1) interest coverage ratio in the bottom tercile of Compustat, and (2) profitability above the median Compustat profitability (Definition B).

Table 1 reports the number of liquidity-driven and other horizontal deals in our sample by year. Out of 1,097 control transactions, 260 deals (or about 23.7% of the sample) are classified as potential liquidity mergers based on below-median interest coverage and above-median profitability. Under the second classification scheme, we identify 136 deals (or about 12.4% of the sample). The overall number of deals in our data set does not increase monotonically through time; for example, it declines in the early 1990s and in the early 2000s. The fraction of liquidity mergers also varies over time (and across industries). Finally, we note that the cyclicality of merger events (mergers waves) and hence the availability of SDC data makes it difficult to identify sufficiently many liquidity mergers in some of the industries of our sample of manufacturers. Using Definition A (B) for financial distress, we can identify liquidity mergers in 85 (64) industries at the three-digit SIC level. To reinforce the results from these two identification schemes, we have also computed the fraction of targets with a below-investment-grade credit rating in our sample. For the deals classified as liquidity merger using Definition A (Definition B) where the target has a credit rating, 81% (93%) are rated below-investment-grade.[29]

Table 2 reports basic summary statistics (means and medians) for empirical proxies related to deal, acquiring-, and target-firm characteristics in our sample based on our primary classification scheme. We tabulate characteristics for both liquidity- and non-liquidity-type mergers. Panel A collects statistics for deal characteristics. It shows that liquidity mergers tend to have a similar transaction value as non-liquidity mergers in absolute terms. Relative to book assets, liquidity-driven acquisitions are, however, valued significantly lower than non-liquidity-driven acquisitions. Liquidity mergers also take longer to complete. According to the statistics in Panel B, *acquirers* in liquidity mergers tend to be smaller (about two-thirds of the size), to hold less cash, to hold more fixed assets, and to be slightly more profitable than acquirers in non-liquidity mergers. On the flip side, Panel C shows that *targets* in liquidity mergers tend to be larger, hold much less cash, and operate more fixed assets than other targets. Notice, in particular, that the average profitability of target firms is higher for liquidity mergers, indicating that the average target in a liquidity merger is not in economic distress. As in prior studies, acquiring firms are generally larger than target firms and tend to have a higher Q than target firms.

We measure the incidence of liquidity mergers in an industry using the ratio of liquidity mergers to the total number of horizontal mergers in that industry. We call this variable *Liquidity mergers*. This variable is summarized in Table 3 together with the other industry variables.[30]

6.2.2. Specificity measures and other industry characteristics

A key element of our theory relates the degree to which assets are firm- and industry-specific. The literature does not offer an empirical counterpart for this element of our model, but we are able to operationalize a proxy that summarizes the relation we want to capture. Our empirical implementation is based on two observations. First, we conjecture that industry-specificity is likely to be greater for assets such as machinery and equipment than for buildings and land. Accordingly, we define "machinery intensity," the ratio of machinery and

[27] The fraction of credit lines that can potentially be used for capital expenditures and acquisitions is significant. Out of 18,050 unique lines of credit initiated between 1987 and 2008, 9,710 fit LPC's investment/acquisitions definition.

[28] We compute interest coverage ratio as Compustat's *oibdp* divided by *xint*. If Compustat data are not available, we use the corresponding data from SDC.

[29] In untabulated results, we have also experimented with replacing profitability by equity analyst earnings forecasts. This alternative classification scheme also supports the main results reported in the paper.

[30] Under Definition A, the correlation of the components of *Transferable assets* is 0.06 (p-value 0.49). The low correlation suggests that the two components capture different aspects of asset transferability.

Table 1
Sample distribution by announcement year.

The sample described in Section 6.1 is based on all domestic mergers and acquisitions with announcement dates between January 1, 1980 and December 31, 2006. A liquidity merger is defined as a merger or acquisition in which the target has interest coverage below the sample median and profitability above the sample median in Compustat (Definition A), or as a merger or acquisition in which the target has interest coverage below the sample 33rd percentile and profitability above the sample median in Compustat (Definition B). Interest coverage is computed as Compustat's *oibdp* divided by *xint* and profitability is the ratio of *oibdp* over *at*. If Compustat data are not available, we use the corresponding data items from SDC.

Announcement year	Liquidity merger (Def. A)		Liquidity merger (Def. B)		All mergers
	Yes	No	Yes	No	
1980	2	8	0	10	10
1981	10	14	6	18	24
1982	7	20	4	23	27
1983	7	15	4	18	22
1984	9	15	3	21	24
1985	11	17	6	22	28
1986	10	33	3	40	43
1987	11	28	5	34	39
1988	15	39	10	44	54
1989	14	30	5	39	44
1990	10	18	8	20	28
1991	6	20	4	22	26
1992	6	17	3	20	23
1993	7	24	5	26	31
1994	10	31	4	37	41
1995	12	28	3	37	40
1996	8	35	7	36	43
1997	7	56	5	58	63
1998	15	62	6	71	77
1999	17	66	6	77	83
2000	16	62	8	70	78
2001	12	39	7	44	51
2002	9	19	2	26	28
2003	11	28	10	29	39
2004	6	28	5	29	34
2005	3	40	3	40	43
2006	9	45	4	50	54
Total	260	837	136	961	1,097

Table 2
Summary statistics for control transactions.

This table reports means and medians for empirical proxies related to deal, acquiring-, and target-firm characteristics. The sample described in Section 6.1 is based on all domestic mergers and acquisitions with announcement dates between January 1, 1980 and December 31, 2006. A liquidity merger is defined as a merger or acquisition in which the target has interest coverage below the sample median and profitability above the sample median in Compustat. *Transaction value* ($ million) is the total value of consideration paid by the acquirer, excluding fees and expenses. *Assets* is defined as total book value of assets. *Days to completion* is measured as the number of calendar days between the announcement and effective dates. *Cash* includes cash and marketable securities. *EBIT* equals cash flow minus depreciation. *Return on assets* is defined as cash flow scaled by assets. *PPE* is property, plant, and equipment.

	Liquidity merger		
	Yes Mean [Median]	No Mean [Median]	All Mean [Median]
Panel A: Deal characteristics			
Transaction value (TV)	670.58	784.82	770.52
	[125.25]	[97.90]	[100.60]
TV/Assets	1.08	2.36	2.17
	[0.66]	[1.19]	[1.13]
Days to completion	146.28	118.63	122.09
	[121]	[102]	[106]
Panel B: Acquirer characteristics			
Assets	4,380.8	6,248.9	6,120.0
	[1,155.5]	[1,125.0]	[1,117.8]
Cash/Assets (%)	9.98	14.82	14.30
	[3.70]	[8.15]	[7.66]
EBIT/Assets (%)	9.65	7.07	7.37
	[9.37]	[9.55]	[9.57]
Return on assets (%)	13.28	11.05	11.31
	[12.89]	[13.52]	[13.51]
PPE/Assets (%)	28.66	23.49	24.04
	[26.17]	[20.10]	[20.52]
Q	1.54	2.39	2.31
	[1.33]	[1.72]	[1.65]
Panel C: Target characteristics			
Assets	801.69	619.92	646.23
	[234.45]	[89.21]	[100.8]
Cash/Assets (%)	5.58	17.72	15.82
	[2.02]	[9.49]	[6.46]
EBIT/Assets (%)	9.70	2.91	3.99
	[8.40]	[6.08]	[7.24]
Return on assets (%)	14.99	7.87	9.04
	[13.50]	[11.04]	[11.99]
PPE/Assets (%)	30.14	26.42	27.30
	[29.10]	[23.44]	[24.61]
Q	1.35	1.99	1.84
	[1.19]	[1.40]	[1.33]

equipment (Compustat's *ppenme*) to total firm assets (*at*), as a proxy for industry asset-specificity.[31] Second, we conjecture that firm-specificity should be inversely related to the degree of activity in the asset resale market in a firm's industry: the higher the use of second-hand capital amongst different firms in an industry, the less firm-specific is the capital. To construct a measure of "capital salability" within an industry, we hand-collect data for used and new capital acquisitions from the Bureau of Census' *Economic Census*. These data are compiled by the Bureau once every five years from 1967 to 1997 and allow us to gauge asset salability by computing the ratio of used-to-total (i.e., used plus new) fixed depreciable capital expenditures by firms in an industry. The approach follows that of Almeida and Campello (2007).

Combining those two observations, we construct our desired proxy as the product of "machine intensity" and "capital salability" proxies. Simply put, we multiply the amount of hard assets needed to operate in an industry by the salability of those assets. As the Bureau of Census'

[31] We have verified that our results are robust to the use of alternative definitions for machinery intensity. For instance, in untabulated tests we scale *ppenme* by *ppent* (i.e., property, plant, and equipment instead of total assets). We also use a proxy given by $1-(ppneb+ppneli)/at$, where the items in parentheses correspond to buildings and land, respectively. We decided in favor of our measure of asset industry-specificity because it maximizes the sample size.

Table 3
Summary statistics for industry-level variables.

This table reports summary statistics for time-invariant proxies of industry characteristics during the 1980–2006 period. A liquidity merger is defined as a merger or acquisition in which the target has interest coverage below the sample median and profitability above the sample median in Compustat (Definition A), or as a merger or acquisition in which the target has interest coverage below the sample 33rd percentile and profitability above the sample median in Compustat (Definition B). *Liquidity mergers* is defined as the three-digit SIC industry's ratio of liquidity mergers to the total number of horizontal mergers in that industry between January 1, 1980 and December 31, 2006 for the sample described in Section 6.1. *Transferable assets* is defined as machine intensity (*ppenme/at*) multiplied by 100 times the ratio of used divided by used plus new capital, from the Bureau of Census' *Economic Census. Industry concentration* is defined as the three-digit SIC industry's Herfindahl index (based on sales). *Industry interest coverage* is defined as the three-digit SIC industry's average interest coverage. *Industry capacity utilization* is defined as the three-digit SIC industry's capacity utilization, which is available from the Federal Reserve's *Statistical Release G.17. Industry Q* is defined as the three-digit SIC industry's average Q. All variables are time-invariant industry-level averages and winsorized at the 5% level.

	Mean	Median	Std. dev.	25th Pct.	75th Pct.	Obs.
Panel A: Definition A						
Liquidity mergers	0.204	0.167	0.125	0.104	0.273	85
Transferable assets	0.397	0.326	0.299	0.183	0.486	85
Industry concentration	0.011	0.008	0.008	0.005	0.012	85
Industry interest coverage	28.11	23.16	21.11	14.53	36.92	85
Industry capacity utilization	0.788	0.782	0.028	0.765	0.808	83
Industry Q	3.306	1.832	3.393	1.375	3.206	85
Panel B: Definition B						
Liquidity mergers	0.142	0.111	0.096	0.071	0.200	64
Transferable assets	0.405	0.357	0.307	0.191	0.483	64
Industry concentration	0.010	0.007	0.009	0.005	0.010	64
Industry interest coverage	27.685	22.778	21.763	14.053	36.897	64
Industry capacity utilization	0.786	0.776	0.027	0.765	0.808	63
Industry Q	3.251	1.951	3.048	1.464	3.616	64

data end in 1997, we create a time-invariant variable by averaging across firms and time within three-digit SIC industries.[32] We call this composite proxy *Transferable assets*. We similarly construct proxies for other industry characteristics that we use as controls in our empirical tests. *Industry concentration* is defined as the three-digit SIC sales-based industry's Herfindahl index. *Industry interest coverage*is defined as the three-digit SIC-level average firm coverage ratio. *Industry capacity utilization* is the three-digit SIC industry's capacity utilization (available from the Federal Reserve's *Statistical Release G.17*), and *Industry Q* is the three-digit SIC-level average firm *Q*. In some cases, these industry-level variables contain extreme observations. To avoid biases due to outliers, these control variables are also winsorized at the 5% level. The industry-level variables are summarized in Table 3.

6.2.3. Line of credit usage and other firm-level data

We follow Sufi (2009) in the definitions of the variables that we use for our credit line tests. Using Compustat fields, we denote by *Assets* the difference between total assets (*at*) and cash (*che*). *Tangibility* is equal to *ppent* scaled by *Assets*. *Size* is defined as the log of *Assets*. *Q* is defined as a cash-adjusted, market-to-book asset ratio, $(Assets+prcc\_fc \times sho-ceq)/Assets$. *NetWorth* is defined as (*ceq–che*)/*Assets*. *Profitability* is the ratio of Earnings Before Interest, Taxes, Depreciation and Amortization (EBITDA) over *Assets*. *Age* is measured as the difference between the current year and the first year in which the firm appeared in Compustat. Industry sales volatility (*IndSaleVol*) is the (three-digit SIC) industry median value of the within-year standard deviation of quarterly changes in firm sales (*saleq* minus its lagged value) scaled by the average asset value in the year. Profit volatility (*ProfitVol*) is the firm-level standard deviation of annual changes in the level of EBITDA, calculated using four lags, and scaled by average assets in the lagged period. We winsorize the Compustat variables symmetrically at the 5% level.

When using the *Random sample*, we measure the fraction of total corporate liquidity that is provided by credit lines for firm *i* in year *t* using both total and unused credit lines:

$$Total\ LC\text{-}to\text{-}cash_{i,t} = \frac{Total\ line_{i,t}}{Total\ line_{i,t}+Cash_{i,t}}, \tag{27}$$

and

$$Unused\ LC\text{-}to\text{-}cash_{i,t} = \frac{Unused\ line_{i,t}}{Unused\ line_{i,t}+Cash_{i,t}}. \tag{28}$$

As discussed by Sufi, while some firms may have higher demand for total liquidity due to better investment opportunities, these *LC-to-cash* ratios should isolate the *relative* usage of lines of credit versus cash in corporate liquidity management.

When using the *LPC sample*, we construct a proxy for line of credit usage in the following way. For each firm-quarter, we measure credit line availability at date *t* by summing all existing (investment-purpose) credit lines that have not yet matured. This calculation assumes that lines of credit remain open until they mature. Specifically, we define our measure of line of credit availability for

[32] This index is multiplied by 100 to make magnitudes more comparable to the other industry proxies reported below.

each firm-quarter (j, s) as

$$Total\ Acq\ LC_{j,s} = \sum_{t \leq s} Acq\ LC_{j,t}\Gamma(Maturity_{j,t} \geq s-t), \quad (29)$$

where $\Gamma(\cdot)$ represents the indicator function, and the variables *Acq LC* and *Maturity* are defined above. We convert these firm-quarter measures into firm-year measures by computing the average value of *Total Acq LC* in each year. We then measure the fraction of corporate liquidity that is provided by investment-related lines of credit for firm j in quarter s using the following variable:

$$Acq\ LC\text{-}to\text{-}Cash_{j,t} = \frac{Total\ Acq\ LC_{j,t}}{Total\ Acq\ LC_{j,t} + Cash_{j,t}}. \quad (30)$$

This ratio is closely related to the *Total LC-to-cash* ratio of Eq. (27), with the important difference that it includes only credit lines that are used for investment purposes.

Table 4 reports summary statistics on firm-level variables for both samples. Panel A describes the statistics for the *LPC sample*. Panel B describes the *Random sample*. The distribution for most of the variables is very similar across the two samples. The main difference between the two samples is that the LPC DealScan data are biased towards large firms. For example, median assets are equal to $255 million in the *LPC Sample* and $116 million in the *Random sample*. Consistent with this difference, firms in the *LPC sample* are also older, have lower *Q*s, and lower income volatility. The measure of line of credit availability in the *LPC sample* (*Acq LC-to-cash*) is lower than the corresponding measures in the *Random sample* (*Total LC-to-cash* and *Unused LC-to-cash*). For example, the average value of *Acq LC-to-cash* in the *LPC sample* is 0.22, while the average value of *Total LC-to-cash* is 0.51. This difference reflects the fact that the *Acq LC-to-cash* measure includes only investment-related credit lines, and also the possibility that LPC DealScan may fail to report some credit lines.

As described above, we use standard proxies for financial distress to identify targets that may be liquidity constrained (targets of liquidity mergers). However, we can use the financial data described in Table 4 to provide additional evidence that targets in the mergers that we identify as liquidity mergers are short in liquid funds.

We do this by examining the gap between investment plans and available funds for target firms prior to the liquidity merger. It is difficult to operationalize this financing gap measure since observed data on investment spending by target firms (presumably financially constrained) will not tell us what their "unconstrained" plans would look like. As a proxy for those plans, however, we can look at the investment spending of industry players that are likely to be financially unconstrained according to various criteria used in the literature (see, e.g., Almeida, Campello, and Weisbach, 2004). We do this by looking at the ratio of investment expenditures to total assets of same (three-digit SIC) industry firms that are large (top quartile of asset size distribution) and have rated bonds; we call this construct *TargetInvestment*. We also compute

Table 4
Summary statistics for firm-level variables.

This table reports basic summary statistics for time-variant proxies of firm characteristics during the 1987–2008 period. *Acq LC-to-cash* is defined as the fraction of corporate liquidity that is provided by investment-related lines of credit. *Assets* are firm assets net of cash, measured in millions of dollars. *Tangibility* is PPE over assets. *Q* is defined as a cash-adjusted, market-to-book assets ratio. *NetWorth* is the book value of equity minus cash over total assets. *Profitability* is the ratio of EBITDA over net assets. Industry sales volatility (*IndSaleVol*) is the (three-digit SIC) industry median value of the within-year standard deviation of quarterly changes in firm sales, scaled by the average quarterly gross asset value in the year. *ProfitVol* is the firm-level standard deviation of annual changes in the level of EBITDA, calculated using four lags, and scaled by average gross assets in the lagged period. Firm *Age* is measured as the difference between the current year and the first year in which the firm appeared in Compustat. *Unused LC-to-cash* and *Total LC-to-cash* measure the fraction of total corporate liquidity that is provided by credit lines using unused and total credit lines.

	Mean	Median	Std. dev.	25th Pct.	75th Pct.	Obs.
LPC sample (LPC DealScan sample):						
Acq LC-to-cash	0.215	0.000	0.354	0.000	0.394	22,333
Tangibility	0.310	0.281	0.176	0.175	0.414	20,955
Assets	2392.38	255.19	12,841.67	53.71	1081.43	20,968
Q	1.985	1.498	1.302	1.130	2.267	19,231
NetWorth	0.360	0.393	0.268	0.228	0.550	20,955
Profitability	0.134	0.141	0.122	0.086	0.202	20,913
IndSalVol	0.038	0.033	0.023	0.025	0.043	22,589
ProfitVol	0.066	0.049	0.052	0.027	0.089	22,593
Age	19.435	14.000	15.525	7.000	31.000	22,593
Random sample [Sufi (2009) sample]:						
Unused LC-to-cash	0.450	0.455	0.373	0.000	0.822	1,906
Total LC-to-cash	0.512	0.569	0.388	0.000	0.900	1,908
Tangibility	0.332	0.275	0.230	0.146	0.481	1,908
Assets	1441.41	116.41	7682.26	23.98	522.20	1,908
Q	2.787	1.524	3.185	1.069	2.726	1,905
NetWorth	0.426	0.453	0.300	0.284	0.633	1,905
Profitability	0.015	0.126	0.413	0.040	0.198	1,908
IndSalVol	0.043	0.036	0.026	0.024	0.051	1,908
ProfitVol	0.089	0.061	0.078	0.028	0.126	1,908
Age	16.04	10.00	13.40	6.00	23.00	1,908

the amount of liquidity in firms' balance sheets by looking at the sum of their cash holdings, total lines of credit, and cash flows (defined as earnings before extraordinary items plus depreciation) scaled by gross assets; we call this measure *ImmediateLiquidity*. We then compute the difference between *ImmediateLiquidity* and *TargetInvestment*, which we call *LiquiditySurplus*. Notably, because large, unconstrained firms are often more established and in later phases of a firm's lifecycle, it is likely that our measure of unmet financial needs will *underestimate* the real financial needs (or deficits) of targets in a liquidity merger. In addition, notice that the variable *LiquiditySurplus* is expected to be positive for all firms, since it captures the difference between stock (cash and credit lines) and flow variables (capital expenditures). Finally, recall that the credit line variable in the LPC DealScan sample includes all credit lines (both drawn and undrawn), which is another reason why *LiquiditySurplus* may overstate the amount of excess liquidity available to firms in our sample.

We then compare *LiquiditySurplus* from targets in liquidity mergers (as identified by Definition A in Table 1), with the mean and median sample values, using the same sample described above in Table 4. We find that the median value of *LiquiditySurplus* for liquidity merger targets is equivalent to 6% of their assets. In contrast, the median value of *LiquiditySurplus* for the overall sample is substantially larger (14% of assets). A comparison of means delivers the same conclusion (12% for liquidity merger targets versus 18% for the average firm). Keeping in mind that these are very crude measures of unmet liquidity needs that are almost certainly overstating the amount of excess liquidity available to our sample firms, they suggest that targets in liquidity mergers are indeed short on liquidity relative to the typical firm in our sample.

6.3. The use of lines of credit in merger deals

Before we test our theory, we discuss the relevance of credit lines in terms of their size and in terms of their use in mergers in the real world. Research on lines of credit is still limited, but recent papers show that the proportion of lines to total assets is quite significant. Evidence in papers like Sufi (2009) and Campello, Giambona, Graham, and Harvey (2011) shows that the ratio of credit lines over total assets hovers around 20–25% in the US. Of this amount, the average firm draws about 30–35%. The suggestion one gets from these numbers is that firms have access to fairly large pools of liquidity that they may use in case valuable opportunities emerge (including a merger). The average transaction value of liquidity-driven acquisitions in our sample is $671 million, as shown in Table 2, while the average book value of the acquiring firm's assets is $4.4 billion. To the extent that these acquirers have a ratio of credit lines over total assets in the 20–25% range, they have, on average, around US$ 1 billion in lines of credit. These figures suggest that lines of credit can be a sizable source of funding in acquisitions, a fraction of which are of the liquidity-merger type.

We also look for evidence on whether funds under credit lines are used for acquiring other firms' assets. LPC DealScan provides information on the purpose of credit lines at origination. In the analysis below, we focus on the set of line facilities that are likely to be used for acquisitions. Specifically, this set includes lines whose purpose is listed as "acquisition line," "takeover," "capital expenditures," or "corporate purposes." These lines comprise approximately 50% of all credit lines available in LPC DealScan (both in numbers and in value). Naturally, it is possible that some of the credit lines listed under "capital expenditures" and "corporate purposes" may not be used towards acquisitions. However, we observe that even the set of credit lines that is specifically listed as being acquisition-related is quite sizable. Specifically, these lines comprise approximately 10% of all lines available in LPC DealScan, both in terms of numbers and in terms of total value. This amounts to approximately $80 million per firm-year, or 12% of the size of the annual average dollar amount of liquidity-driven acquisitions in our sample ($671 million). The funds under credit lines that are reserved for acquisitions in general, and hence available for potential liquidity mergers in particular, seem significant.

To make our point more concretely, we look at the details of financing arrangements used in recent merger deals. There were multiple deals illustrating our paper's results and we found a deal from our sample: Western Refining Inc.'s acquisition of Giant Industries Inc. in 2007. The deal was closed at $1.22 billion in cash in addition to the assumption of $275 million outstanding debt. The transaction was financed in part with $250 million cash and a $500 million credit line facility. The target of this deal, Giant Industries, also experienced financial distress before the transaction as its capacity to service debt was strained and resulted in problems with refining operations. Yet another example is the merger between Cineplex Odeon Corp. and Sony Corp.'s Loews in 1998. The transaction amounted to over $1 billion in value and was fully financed by lines of credit. At that time Cineplex had breached its debt covenants several times and was in serious need of access to capital to improve. Finally, one example of a cash-financed liquidity merger is the acquisition of Sagent Technology Inc. by Group 1 Software Inc. in 2003.

Importantly, we note that the model does not predict that all of the funds used in liquidity-driven acquisitions should come from credit lines; these facilities should just be sizable enough to make a difference in the odds that a liquidity merger takes place. Likewise, our model is not meant to completely map out the demand for credit lines by firms. Ample evidence suggests that there are other firm-specific needs motivating the use of credit lines by firms. One important observation, however, is that while firms carry relatively large nominal stocks of credit lines (about 20% of assets), relatively smaller margins may really be used at any point in time. Given the relatively large size of liquidity mergers that we document, one could argue that those mergers may move an important margin of the observed demand for lines. Admittedly, however, ours is just one piece of the story about lines of credit.

6.4. Liquidity mergers and asset-specificity

We start by investigating whether the incidence of liquidity mergers is related to asset-specificity in a way that is consistent with our model's prediction. The dependent variable in our analysis is the ratio of liquidity mergers to the total number of mergers in the industry (the variable *Liquidity mergers*). According to our model, liquidity mergers are more likely to arise in industries with high asset-specificity (high machinery intensity), but among firms whose assets are not too firm-specific (high capital salability). Therefore, the model predicts a positive relation between *Liquidity mergers* and *Transferable assets* at the industry-level. Our tests control for other industry characteristics that could affect this relation in the data. Adding *Industry concentration* addresses the alternative explanation that liquidity mergers are simply due to a higher incidence of horizontal mergers in more concentrated industries (e.g., Hackbarth and Miao, 2011). Similarly, including industry-wide measures of financial distress, measured by *Industry interest coverage,* addresses the concern that liquidity mergers are by and large consolidating mergers in distressed industries. Another explanation of mergers is that they are due to technological industry shocks and excess industry capacity (e.g., Mitchell and Mulherin, 1996; Andrade and Stafford, 2004; Harford, Mansi, and Maxwell, 2008). We thus also control for *Industry capacity utilization*. Finally, we add *Industry Q* to the empirical specification to control for overall industry prospects. The empirical model that we estimate has the form

$$\begin{aligned} \textit{Liquidity mergers}_j = a + b_1\ & \textit{Transferable assets}_j \\ & + b_2\ \textit{Industry concentration}_j \\ & + b_3\ \textit{Industry interest coverage}_j \\ & + b_4\ \textit{Industry capacity utilization}_j \\ & + b_5\ \textit{Industry } Q_j + \varepsilon_j, \end{aligned} \tag{31}$$

where the index j denotes a three-digit SIC industry. The model is estimated via ordinary least squares (OLS), but since the dependent variable is censored between zero and one, we also perform Tobit estimations.

Table 5 reports coefficient estimates for a set of regressions in which control variables are progressively introduced. Consistent with the model, those estimates suggest that the effect of our asset-specificity composite on the fraction of liquidity-driven acquisitions is positive and significant. The estimates in column 1 of Panel A, for example, imply that a one-standard-deviation change in *Transferable assets* $(=0.299)$ leads to a 0.042 $(=0.141 \times 0.299)$ increase in the fraction of liquidity mergers in the industry, which is 20.7% of the sample average of liquidity mergers. The economic and statistical significance of the coefficient on *Transferable assets* is similarly strong when we use the definition of liquidity merger that conditions on both bottom-tercile of interest coverage and above-median profitability (Panel B).

Column 2 estimates indicate that market power gains in concentrated industries do not explain the incidence of liquidity mergers. The industry-wide distress proxy included in the model under column 3 does not weaken the reliably positive relation between *Liquidity mergers* and *Transferable assets*. Results in columns 4 and 5 show that industry capacity utilization and Q do not affect the economic or statistical significance of the baseline result of column 1. Next, column 6 combines all industry-wide proxies we consider. The result from this estimation renders a somewhat stronger positive relation between *Liquidity mergers* and *Transferable assets* under both classification schemes. To verify the robustness of our baseline findings using OLS, we re-estimate the model with all variables using a median regression in column 7.[33] Column 8 points to similar findings using a Tobit specification.[34]

Table 5 shows that liquidity mergers are more frequent in industries in which assets are more transferable. It does that by comparing the frequency of liquidity-driven to non-liquidity-driven acquisitions in different industries. An alternative way to provide evidence on the prediction that liquidity mergers are related to asset-specificity is to compare inter- versus intra-industry mergers. The logic in the model would suggest that a financially distressed target is more likely to be acquired by another firm in its industry (given that same-industry firms are the natural providers of liquidity). To put this in other terms, *intra-industry* mergers are more likely to be driven by liquidity motives, when compared to *inter-industry* mergers.

To verify whether this is the case, we define inter-industry mergers as deals between firms from two completely different industries; i.e., different two-digit SIC industries. Using otherwise the same procedures as those listed above, we obtain a sample of 1,281 inter-industry acquisitions in our time period. We find that, in this sample, only 104 (or 8.1%) of firms that were acquired by industry outsiders were financially distressed according to Definition A (alternatively, 68 (5.3%) if we use Definition B). Notably, these fractions are significantly lower than the ones for intra-industry liquidity mergers (23.7% according to Definition A and 12.4% according Definition B in Table 1). These results are consistent with the logic in our model.

6.5. Mergers and asset-specificity following a liquidity shock

An alternative way to test our model is to look at merger deals that take place following shocks to liquidity, focusing on the impact of asset-specificity on those deals. The challenge is to empirically identify a liquidity shock

[33] In untabulated tests, we have also dropped one observation at a time and re-estimated the model with all variables 83 (63) times in case of Definition A (Definition B). These experiments reveal, for example, that the estimated coefficient on *Transferable assets* in case of Definition A ranges from 0.132 to 0.192, with its t-statistics being between 2.43 and 3.68.

[34] As an additional robustness check, we redo our tests excluding firms with a lot of research and development (R&D) activity (given that it is plausibly more difficult to measure asset transferability in these industries). In particular, we redo our tests excluding industries ranked in the top deciles of the Compustat-based industry rankings for all distress definitions. All results are robust to this change in sample definition.

Table 5
Liquidity mergers and transferable assets.

The dependent variable *Liquidity mergers* is the fraction of liquidity mergers by three-digit SIC industry as a fraction of the total number of mergers in that industry between January 1, 1980 and December 31, 2006 for the sample described in Section 6.1. A liquidity merger is defined as a merger or acquisition in which the target has interest coverage below the sample median and profitability above the sample median in Compustat (Panel A), or as a merger or acquisition in which the target has interest coverage below the sample 33rd percentile and profitability above the sample median in Compustat (Panel B). Interest coverage is computed as *oibdp* divided by *xint*. If Compustat data are not available, we use the corresponding data items from SDC. *Transferable assets* is defined as machine intensity (*ppenme/at*), multiplied by 100 times the ratio of used divided by used plus new capital, from the Bureau of Census' *Economic Census*. *Industry concentration* is defined as the three-digit SIC industry's Herfindahl index (based on *sale*). *Industry interest coverage* is defined as the three-digit SIC industry's average interest coverage. *Industry capacity utilization* is defined as the three-digit SIC industry's capacity utilization, which is available from the Federal Reserve's *Statistical Release G.17*. *Industry Q* is defined as the three-digit SIC industry's average Q. All variables are time-invariant industry-level averages and winsorized at the 5% level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, and *t*-statistics based on robust standard errors are in parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Definition A								
Transferable assets	0.141***	0.164***	0.154***	0.139***	0.129**	0.165***	0.239***	0.170***
	(2.66)	(3.13)	(2.84)	(2.70)	(2.22)	(3.03)	(4.06)	(3.99)
Industry concentr.		4.562***				5.087***	3.588	5.453***
		(3.45)				(3.32)	(1.62)	(3.38)
Industry int. cov.			−0.001			−0.001*	−0.001	−0.001
			(1.45)			(1.78)	(1.02)	(1.47)
Industry cap. util.				0.871*		1.085**	0.820	1.112**
				(1.78)		(2.21)	(1.36)	(2.50)
Industry Q					−0.008**	−0.004	−0.005	−0.004
					(2.01)	(1.07)	(1.05)	(1.14)
Constant	0.148***	0.090***	0.165***	−0.539	0.178***	−0.730*	−0.548	−0.763**
	(6.52)	(3.44)	(5.82)	(1.42)	(5.58)	(1.89)	(1.13)	(2.13)
Specification	OLS	OLS	OLS	OLS	OLS	OLS	Median	Tobit
Observations	85	85	85	83	85	83	83	83
R^2	0.12	0.21	0.13	0.16	0.16	0.30	0.17	0.35
Panel B: Definition B								
Transferable assets	0.096**	0.114***	0.119***	0.101**	0.088**	0.135***	0.139***	0.140***
	(2.36)	(2.81)	(3.24)	(2.51)	(2.08)	(4.02)	(3.20)	(4.21)
Industry concentr.		4.219***				4.187***	4.021**	4.506***
		(3.28)				(3.07)	(2.19)	(3.53)
Industry int. cov.			−0.001**			−0.002***	−0.001	−0.002***
			(2.50)			(3.08)	(1.18)	(3.36)
Industry cap. util.				0.551		0.701*	0.286	0.748**
				(1.19)		(1.68)	(0.59)	(2.02)
Industry Q					−0.008**	−0.006*	−0.005	−0.006*
					(2.27)	(1.94)	(0.93)	(1.71)
Constant	0.103***	0.054**	0.129***	−0.335	0.133***	−0.444	−0.163	−0.489
	(5.68)	(2.58)	(6.00)	(0.93)	(5.63)	(1.36)	(0.42)	(1.66)
Specification	OLS	OLS	OLS	OLS	OLS	OLS	Median	Tobit
Observations	64	64	64	63	64	63	63	63
R^2	0.09	0.24	0.17	0.14	0.16	0.41	0.19	0.34

that is not related to the profitability of investment prospects (or underlying asset values). The shock should be such that there is enough cross-sectional variation left regarding firms' ability to engage in acquisitions (as such, an aggregate decline in demand or credit contraction may not work). In addition, the shock should affect enough manufacturing industries, which are required for our measure of industry-but-not-firm asset-specificity (*Transferable assets*).

The collapse of the junk-bond markets in the late 1980s effectively meant that junk-bond issuers lost access to liquidity coming from bonds (they experienced an exogenous shock to the supply of credit). This happened because of events that were orthogonal to the profitability of their investment. In particular, new regulatory standards introduced in 1989 precluded financial institutions such as savings and loans to acquire junk bonds. In the later part of that same year, Drexel-Burnham-Lambert (DBL), a major operator in the junk-bond market arena, was threatened with a Racheteer Influenced and Corrupt Organizations (RICO) indictment by the U.S. Securities and Exchange Commission (SEC). Complications from suspicions about criminal activity at DBL eventually led the firm to file for bankruptcy in February 1990. The combination of these events led to the collapse of the junk-bond markets (as shown in Lemmon and Roberts, 2010). This shock affected firms across many different industries, with different firms within the same industry being differentially affected.

To substantiate our baseline results, we study the patterns of mergers and acquisitions involving the firms that were affected by the junk-bond market collapse. Our investigation starts from the set of bond issuers listed as "below-investment-grade" according to Standard & Poor's (S&P) long-term credit rating. As defined by S&P, firms rated BBB− or higher are defined as "investment-grade";

firms rated BB+ or lower are defined as "below-investment-grade" (or "speculative-grade" or "junk"); firms without an S&P rating are excluded from the analysis. Following Lemmon and Roberts (2010), our sample begins with all firm-year observations in the annual Compustat database between 1986 and 1993. This yields a balanced time frame around the series of events leading to the demise of the junk market, as well as a reasonably large sample of firms potentially affected by this shock. We find 509 manufacturers listed as junk-bond issuers in our Compustat data set. Of this set, we find that 52 firms eventually become targets fitting the description of "financially but not economically distressed" (under Definition A) at the time of the control transaction.

We use this sample to provide additional evidence on the predictions of the model. First, we look at the acquirers' profiles. We find that 32 (or 62%) of those targets were acquired by firms in the same three-digit SIC industry.[35] This number seems high, but in the absence of a benchmark, it is hard to ascertain its significance. We construct multiple benchmarks by computing the rate of same-industry acquisitions in two different settings: (1) target firms that are junk-bond issuers *outside of the 1989 crisis* window; and (2) target firms that are *non-junk-bond issuers* during the 1989 crisis window. These checks are interesting in that they work similarly to "falsification tests" for our identification strategy. They give us a sense of the propensity for liquidity mergers to take place following a liquidity shock relative to the baseline when the liquidity shock *did not* take place (test (1) is a placebo test), and relative to counterfactuals that *were not* affected by the liquidity shock when it happened (test (2) concerns firms that were active in 1989, but that were not directly affected by the shock). As a complement, we also compute the overall sample average of same-industry mergers under Definition A (the unconditional probability of a liquidity merger). This latter number might be seen as a more general comparison benchmark.

The estimates are as follows. During normal times (outside of the 1989 episode), the rate of same-industry acquisitions of junk-bond issuers that become targets under Definition A is 37%. The proportion of non-junk-bond issuers under Definition A that are eventually acquired by same-industry players following the 1989 episode is 28%. Finally, the overall, unconditional ratio of targets under Definition A that are acquired by same-industry players is 43%. While these ratios of liquidity mergers are high (as expected), we find that an acute liquidity event increases those ratios even further. That is, the liquidity merger phenomenon is particularly accentuated in settings where liquidity shocks are sharp.

As an additional check of our story, we use data from the junk-bond collapse era to re-estimate the regressions from Table 5 (which examine the relation between *Liquidity mergers* and *Transferable assets*). The results are reported in Table 6. Consistent with the intuition that experimenting with the salient liquidity shock of the late 1980s might strengthen our model's identification, we find economically larger effects with comparable statistical significance levels despite the smaller sample. In particular, the coefficient estimates for *Transferable assets* often more than double relative to the baseline estimation results in Table 5. Most of the other (control) variables have coefficient estimates of similar magnitudes.[36]

While the tests of this section pertain to a smaller set of data, they followed a different, unique identification strategy. These tests substantiate our model's prediction that, when faced with liquidity shocks, firms may engage in merger deals in which their assets are transferred towards other firms in their same industry depending on the level of asset-specificity.

6.6. Lines of credit and asset-specificity

Another implication of our model is that firms are more likely to use credit lines if industry asset-specificity is high, but firm asset-specificity is low. We test this implication by relating our three alternative credit line variables (those in Eq. (27), (28), and (30)) to the composite proxy for industry-not-firm-specificity that we constructed, *Transferable assets*. We also include in the empirical model the main determinants of credit line usage suggested by Sufi (2009), in addition to the industry variables that we use in the tests of Section 6.4:

$$\begin{aligned} \textit{LC-to-cash}_{i,t} = {} & \alpha + \beta_1 \textit{Transferable assets}_j + \beta_2 \ln(\textit{Age})_{i,t} \\ & + \beta_3 (\textit{Profitability})_{i,t-1} + \beta_4 \textit{Size}_{i,t-1} + \beta_5 Q_{i,t-1} \\ & + \beta_6 \textit{NetWorth}_{i,t-1} + \beta_7 \textit{IndSalVol}_{j,t} \\ & + \beta_8 \textit{ProfitVol}_{i,t} + \beta_9 \textit{Industry concentration}_j \\ & + \beta_{10} \textit{Industry interest coverage}_j \\ & + \beta_{11} \textit{Industry capacity utilization}_j \\ & + \beta_{12} \textit{Industry } Q_j + \varepsilon_{i,t}, \end{aligned} \tag{32}$$

where the index j denotes a three-digit SIC industry, the index i denotes a firm, and the index t denotes a year. Our model predicts that the coefficient β_1 should be positive. Since the dependent variable is censored between zero and one, we also perform Tobit estimations. Because several of the variables are measured at the industry-level, we cluster standard deviations by three-digit SIC industry whenever the industry variables are included in the regression. In other cases, the standard errors are clustered at the firm-level.

We start by providing some descriptive evidence that shows that the variable *Transferable assets* is positively correlated with line of credit usage in liquidity management, as predicted by our model. This pattern is shown visually in Fig. 3, which uses the *LPC sample* and depicts the average usage of credit lines as measured by *Acq LC-to-cash* against *Transferable assets*, by three-digit SIC

[35] A much smaller number of 14 was acquired by firms in completely different lines of business; i.e., different two-digit SIC industries.

[36] We further check whether the results in Table 6 change with the inclusion of coverage ratio and leverage as control variables. We do this to minimize concerns that other correlated financial effects (and not asset transferability) might drive our findings. Our results remain unchanged (tables available upon request).

Table 6
Liquidity mergers and transferable assets after a liquidity shock.

The tests in this table are based on the set of bond issuers listed as ''below-investment grade'' according to Standard & Poor's long-term credit rating between 1986 and 1993; firms without an S&P rating are excluded from the analysis. The dependent variable *Liquidity mergers* is the fraction of liquidity mergers by three-digit SIC industry as a fraction of the total number of mergers in the sample for that industry after 1989, which is described in Section 6.5. A liquidity merger is defined as a merger or acquisition in which the target has interest coverage below the sample median and profitability above the sample median in Compustat (Panel A), or as a merger or acquisition in which the target has interest coverage below the sample 33rd percentile and profitability above the sample median in Compustat (Panel B). Interest coverage is computed as *oibdp* divided by *xint*. If Compustat data are not available, we use the corresponding data items from SDC. *Transferable assets* is defined as machine intensity (*ppenme/at*), multiplied by 100 times the ratio of used divided by used plus new capital, from the Bureau of Census' *Economic Census. Industry concentration* is defined as the three-digit SIC industry's Herfindahl index (based on *sale*). *Industry interest coverage* is defined as the three-digit SIC industry's average interest coverage. *Industry capacity utilization* is defined as the three-digit SIC industry's capacity utilization, which is available from the Federal Reserve's *Statistical Release G.17. Industry Q* is defined as the three-digit SIC industry's average Q. All variables are time-invariant industry-level averages and winsorized at the 5% level. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, and *t*-statistics based on robust standard errors are in parentheses.

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Panel A: Definition A								
Transferable assets	0.498***	0.560***	0.487***	0.482***	0.542***	0.465**	0.740**	0.474**
	(3.21)	(3.56)	(3.04)	(2.79)	(2.85)	(2.28)	(2.07)	(2.47)
Industry concentr.		17.217**				25.306***	31.524**	26.529***
		(2.57)				(3.00)	(2.53)	(3.69)
Industry int. cov.			0.001			0.003	0.004	0.003
			(0.26)			(0.86)	(0.80)	(1.17)
Industry cap. util.				0.804		1.266	2.621	1.339
				(0.56)		(0.81)	(1.15)	(1.10)
Industry Q					−0.019	−0.004	0.011	−0.003
					(1.42)	(0.36)	(0.52)	(0.26)
Constant	0.402***	0.231***	0.383***	−0.228	0.451***	−0.852	−2.202	−0.940
	(6.65)	(3.12)	(3.82)	(0.20)	(5.83)	(0.66)	(1.17)	(0.93)
Specification	OLS	OLS	OLS	OLS	OLS	OLS	Median	Tobit
Observations	35	35	35	34	35	34	34	34
R^2	0.14	0.30	0.15	0.14	0.19	0.41	0.41	0.45
Panel B: Definition B								
Transferable assets	0.461**	0.574***	0.452**	0.442*	0.643**	0.520*	0.325**	0.554**
	(2.35)	(3.06)	(2.23)	(1.91)	(2.62)	(2.05)	(2.53)	(2.33)
Industry concentr.		14.916**				23.535***	28.192	24.411***
		(2.23)				(3.01)	(1.70)	(2.97)
Industry int. cov.			0.001			0.004	0.001	0.004
			(0.19)			(0.77)	(0.09)	(1.24)
Industry cap. util.				3.562**		3.819**	4.866	4.030**
				(2.41)		(2.24)	(1.48)	(2.39)
Industry Q					−0.035*	−0.005	−0.017	−0.006
					(1.84)	(0.24)	(0.40)	(0.33)
Constant	0.372***	0.202*	0.354***	−2.422*	0.430***	−2.911*	−3.632	−3.106**
	(4.61)	(1.94)	(2.88)	(2.06)	(3.99)	(2.04)	(1.33)	(2.26)
Specification	OLS	OLS	OLS	OLS	OLS	OLS	Median	Tobit
Observations	26	26	26	25	26	25	25	25
R^2	0.12	0.24	0.12	0.24	0.24	0.48	0.29	0.36

industry.[37] The figure shows that investment-related line of credit usage is more prevalent in industries with transferable assets.

In Table 7 we provide the results of estimating Eq. (32) for the *LPC sample*. We start in column 1 by running a specification that is closely related to that in Sufi's (2009, Table 3).[38] In particular, the coefficients on profitability, size, net worth, and Q are virtually identical to those in Sufi (although the coefficient on profitability is not significant in column 1). These coefficients indicate that large, low Q, and low net worth firms are more likely to use investment-related credit lines in liquidity management, relative to cash holdings. In column 2, we run a simple regression of *Acq LC-to-cash* on *Transferable assets*. Consistent with Fig. 3, the correlation between *Acq LC-to-cash* and *Transferable assets* is positive and significant. Without controlling for other variables, the coefficient on *Transferable assets* is 0.17, significant at a 1% level. *Transferable assets* remains significant after including all firm-level controls (column 3); the coefficient drops to 0.09, but remains statistically significant. Column 4 shows that firms in industries with high capacity utilization, low interest coverage, and high concentration are more likely to use credit lines relative to cash. In addition, *Transferable assets* remains statistically significant and similar in

[37] To construct the measure of line of credit usage at the industry-level, we compute the average value of *Acq LC-to-cash* for each three-digit SIC industry over the entire sample period. We require a three-digit SIC industry to have more than five firms to appear in the figure.

[38] In this regression, we follow Sufi and also include one-digit SIC industry dummies. Naturally, we do not include industry dummies in the specifications which contain time-invariant industry variables (those in the other columns).

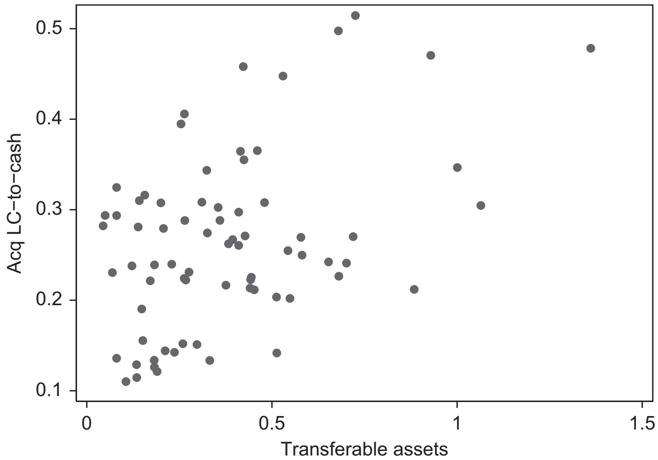

Fig. 3. Line of credit availability and transferable assets. It depicts the relationship between line of credit availability and our composite proxy for industry-but-not-firm-specificity (*Transferable assets*) for the *LPC sample* described in Section 6.1. On the *y*-axis, we depict the ratio of total credit lines divided by total credit lines plus cash balances (the variable *Acq LC-to-cash* in Eq. (32) in the text). On the *x*-axis, we depict the variable *Transferable assets*. The data represent three-digit SIC industry averages over our entire sample period (1987–2008), for industries with five or more firms.

economic magnitude after including all of these industry controls together with firm-level variables. Finally, column 5 shows the results of using a Tobit specification. All of the coefficients are consistent with those in the previous columns.

The relation between *Acq LC-to-cash* and *Transferable assets* that we estimate in Table 7 also appears to be economically significant. For example, the OLS coefficient on columns 3 and 4 (which is approximately equal to 0.09) implies that a one-standard-deviation increase in *Transferable Assets* (which is equal to 0.30 according to Table 3) increases *Acq LC-to-cash* by 0.027, or approximately 13% of the mean value of *Acq LC-to-cash* (which is 0.21 in Table 4).

One potential concern with these results is that they are based on LPC DealScan measures of line of credit availability, which are biased towards larger firms. Another limitation of these data is that they tend to overestimate the amount of credit available to firms (since we cannot measure credit line drawdowns). To show that the results are not driven by these issues, we experiment with our *Random sample*, which addresses both of these problems. The results are presented in Table 8.

In the first four columns of Table 8, we use the variable *Total LC-to-cash*, which includes both used and unused portions of firms' credit lines. Column 1 replicates the results in column 3 of Sufi's (2009) Table 3. The coefficients indicate that profitable, large, low net worth, low *Q*, seasonal, and less volatile firms are more likely to use credit lines in corporate liquidity management.[39] In column 2 we relate *Total LC-to-cash* to *Transferable assets*, without controlling for other variables. Consistent with previous results, this column suggests that firms use more credit lines to manage liquidity when they belong to industries with firm-specific, but transferable assets. Column 3 shows that this relation continues to hold after controlling for firm-level variables. Finally, column 4 includes industry variables and shows that the relation between *Total LC-to-cash* and *Transferable assets* continues to hold.

Similarly to Table 7, the results in columns 1 to 5 in Table 8 do not address the potential overestimation of the amount of credit available to firms at a point in time, since they use total, as opposed to unused credit lines. To this end, columns 6–10 in Table 8 use *Unused LC-to-cash* and show that this measurement issue does not affect the patterns previously reported. In particular, *Unused LC-to-cash* and *Transferable assets* continue to be positively related, before and after including firm- and industry-level controls.[40] Finally, we note that the economic magnitude of the correlation between *Transferable assets* and credit line usage in this sample is also sizable. For example, using the coefficients in columns 4 and 9 to measure this correlation, we find that a one-standard-deviation change in *Transferable assets* increases *Total LC-to-cash* by 0.10, and *Unused LC-to-cash* by 0.08. These magnitudes represent 20% and 18% of their respective sample averages (see Table 4). These results are consistent with the predictions of our theoretical model.

7. Concluding remarks

While mergers and asset acquisitions are some of the most important types of corporate investment, we know relatively little about the way firm financial policies are affected by those transactions. Likewise, we know little about how real asset allocations across firms are affected by corporate financial policies. Our paper sheds light on these issues by modeling the interaction between

[39] Note that the positive relation between profitability and *LC-to-cash* is consistent with Implication 4 of the theory.

[40] Column 5 replicates the results in column 5 of Table 3 in Sufi (2009).

Table 7
Line of credit availability and transferable assets: *LPC sample*.

The dependent variable is *Acq LC-to-cash*, the fraction of corporate liquidity that is provided by investment-related lines of credit. The data for lines of credit come from LPC DealScan, for the period of 1987–2008. *Profitability* is the ratio of EBITDA over net assets. *Tangibility* is PPE over assets. *Assets* are firm assets net of cash, measured in millions of dollars. *NetWorth* is the book value of equity minus cash over total assets. Q is defined as a cash-adjusted, market-to-book assets ratio. Industry sales volatility (*IndSaleVol*) is the (thee-digit SIC) industry median value of the within-year standard deviation of quarterly changes in firm sales, scaled by the average quarterly gross asset value in the year. *ProfitVol* is the firm-level standard deviation of annual changes in the level of EBITDA, calculated using four lags, and scaled by average gross assets in the lagged period. Firm *Age* is measured as the difference between the current year and the first year in which the firm appeared in Compustat. *Transferable assets* is defined as machine intensity (*ppenme/at*) multiplied by 100 times the ratio of used divided by used plus new capital, from the Bureau of Census' *Economic Census*. *Industry concentration* is defined as the thee-digit SIC industry's Herfindahl index (based on sales). *Industry interest coverage* is defined as the three-digit SIC industry's average interest coverage. *Industry capacity utilization* is defined as the three-digit SIC industry's capacity utilization, which is available from the Federal Reserve's *Statistical Release G.17*. *Industry Q* is defined as the three-digit SIC industry's average Q. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, and *t*-statistics based on robust standard errors are in parentheses.

Dep. var.: *Acq LC-to-cash*	(1)	(2)	(3)	(4)	(5)
Transferable assets		0.165***	0.095***	0.087***	0.135**
		(4.23)	(3.14)	(3.10)	(2.12)
Profitability	0.027		0.0049	0.013	0.226**
	(0.84)		(0.17)	(0.38)	(2.07)
Tangibility	−0.039		−0.033	−0.059*	−0.207**
	(1.29)		(1.00)	(1.89)	(2.43)
Assets	0.026***		0.028***	0.027***	0.092***
	(7.43)		(6.73)	(6.71)	(9.81)
NetWorth	−0.100***		−0.095***	−0.093***	−0.266***
	(5.63)		(4.89)	(4.96)	(4.88)
Q	−0.042***		−0.038***	−0.038***	−0.094***
	(14.51)		(12.28)	(11.85)	(9.73)
IndSalVol	0.336		0.382	0.237	0.242
	(1.58)		(1.50)	(0.87)	(0.36)
ProfitVol	−0.181**		−0.150*	−0.108	0.108
	(2.00)		(1.79)	(1.24)	(0.43)
Age	−0.018**		−0.019**	−0.019**	−0.054**
	(2.33)		(2.22)	(2.23)	(2.55)
Industry concentration				3.171***	7.291***
				(2.97)	(3.42)
Industry interest coverage				−0.001***	−0.001**
				(2.66)	(2.14)
Industry capacity utilization				0.512**	0.848
				(2.19)	(1.51)
Industry Q				−0.001	−0.003
				(0.65)	(0.69)
Constant	0.261***	0.162***	0.218***	−0.167	−1.717***
	(8.47)	(8.04)	(6.27)	(0.90)	(3.90)
Cluster	Firm	Industry	Industry	Industry	Industry
Industry dummies?	Yes	No	No	No	No
Year dummies?	Yes	Yes	Yes	Yes	Yes
Specification	OLS	OLS	OLS	OLS	Tobit
Observations	19,034	22,333	19,034	18,922	18,922
R^2	0.10	0.07	0.10	0.11	0.07

corporate liquidity and asset reallocation opportunities. The model embeds the Holmstrom and Tirole (1997, 1998) liquidity demand theory in an industry equilibrium framework that draws on Shleifer and Vishny (1992).

Our model implies that financially distressed firms might be acquired by other firms in the same industry, even when there are no operational synergies. We call such transactions "liquidity mergers." The main purpose of these deals is to reallocate liquidity from firms that have liquidity to those that may be inefficiently liquidated due to a liquidity shortfall. Analyzing firms' optimal liquidity policies as a function of future real asset reallocation opportunities, we find that lines of credit are a particularly attractive way of financing liquidity-driven acquisitions. This theoretical finding is interesting because it provides a rationale to the (counterintuitive) empirical regularity that profitable, well-capitalized firms are the heaviest users of credit line facilities.

Besides shedding new light on existing empirical findings, our model has several implications that have not yet been examined. For example, our model predicts that liquidity mergers should be more prevalent in industries with high asset-specificity, but among firms whose assets are not too firm-specific. The model also predicts that firms in these industries should be more likely to use lines of credit, generating an equilibrium relation between line of credit usage and the incidence of liquidity mergers. We put together a comprehensive data set to explore our model's empirical implications and find evidence that supports those implications. Our empirical tests are, by design, quite basic and meant to motivate future research on the link between mergers and

Table 8

Line of credit availability and transferable assets: *Random sample*.

The dependent variables are *Total LC-to-cash* and *Unused LC-to-cash*, which measure the fraction of total corporate liquidity that is provided by credit lines using total and unused credit lines, respectively. The data for lines of credit are provided by Amir Sufi, for the period of 1996–2003. *Profitability* is the ratio of EBITDA over net assets. *Tangibility* is PPE over assets. *Assets* are firm assets net of cash, measured in millions of dollars. *NetWorth* is the book value of equity minus cash over total assets. *Q* is defined as a cash-adjusted, market-to-book assets ratio. Industry sales volatility (*IndSaleVol*) is the (three-digit SIC) industry median value of the within-year standard deviation of quarterly changes in firm sales, scaled by the average quarterly gross asset value in the year. *ProfitVol* is the firm-level standard deviation of annual changes in the level of EBITDA, calculated using four lags, and scaled by average gross assets in the lagged period. Firm *Age* is measured as the difference between the current year and the first year in which the firm appeared in Compustat. *Transferable assets* is defined as machine intensity (*ppenme/at*) multiplied by 100 times the ratio of used divided by used plus new capital, from the Bureau of Census' *Economic Census*. *Industry concentration* is defined as the three-digit SIC industry's Herfindahl index (based on sales). *Industry interest coverage* is defined as the three-digit SIC industry's average interest coverage. *Industry capacity utilization* is defined as the three-digit SIC industry's capacity utilization, which is available from the Federal Reserve's *Statistical Release G.17*. *Industry Q* is defined as the three-digit SIC industry's average *Q*. *, **, and *** denote statistical significance at the 10%, 5%, and 1% level, and *t*-statistics based on robust standard errors are in parentheses.

Panel A—Dep. var.: Total LC-to-cash	(1)	(2)	(3)	(4)	(5)
Transferable assets		0.723***	0.318**	0.321**	0.353**
		(4.39)	(2.33)	(2.20)	(2.07)
Profitability	0.078**		0.067*	0.082***	0.266***
	(2.27)		(1.97)	(2.69)	(3.52)
Tangibility	0.040		0.104	0.097	0.173
	(0.56)		(1.17)	(1.12)	(1.43)
Assets	0.047***		0.039***	0.039***	0.052***
	(5.12)		(3.30)	(3.23)	(3.50)
NetWorth	−0.097**		−0.185***	−0.173***	−0.233**
	(2.30)		(3.06)	(3.17)	(2.51)
Q	−0.036***		−0.039***	−0.039***	−0.066***
	(8.51)		(8.83)	(8.64)	(7.61)
IndSalVol	1.094*		1.301	1.630*	2.314**
	(1.69)		(1.49)	(1.84)	(2.26)
ProfitVol	−0.596***		−0.550*	−0.489*	−0.338
	(3.22)		(1.85)	(1.88)	(0.90)
Age	−0.039*		−0.047*	−0.040	−0.059*
	(1.85)		(1.75)	(1.58)	(1.88)
Industry concentration				1.229	0.459
				(0.37)	(0.12)
Industry interest coverage				−0.002*	−0.002**
				(1.88)	(2.08)
Industry capacity utilization				1.046	1.119
				(1.08)	(1.00)
Industry Q				0.001	0.002
				(0.14)	(0.26)
Constant	0.239**	0.272***	0.524***	−0.299	−0.530
	(2.42)	(4.46)	(4.91)	(0.38)	(0.59)
Cluster	Firm	Industry	Industry	Industry	Industry
Industry dummies?	Yes	No	No	No	No
Year dummies?	Yes	Yes	Yes	Yes	Yes
Specification	OLS	OLS	OLS	OLS	Tobit
Observations	1,905	900	900	900	900
R^2	0.40	0.11	0.40	0.41	0.37

Panel B—Dep. Var.: Unused LC-to-cash	(6)	(7)	(8)	(9)	(10)
Transferable assets		0.645***	0.260**	0.254*	0.289*
		(4.13)	(2.05)	(1.91)	(1.84)
Profitability	0.061*		0.044	0.059**	0.252***
	(1.96)		(1.48)	(2.17)	(3.55)
Tangibility	0.025		0.079	0.071	0.127
	(0.37)		(0.90)	(0.82)	(1.01)
Assets	0.053***		0.047***	0.046***	0.061***
	(6.12)		(3.81)	(3.68)	(4.15)
NetWorth	−0.054		−0.138***	−0.127***	−0.165*
	(1.40)		(2.87)	(2.88)	(1.86)
Q	−0.029***		−0.034***	−0.034***	−0.061***
	(7.28)		(9.35)	(9.07)	(7.71)
IndSalVol	1.042		1.051	1.285	1.948*
	(1.55)		(1.20)	(1.40)	(1.82)
ProfitVol	−0.554***		−0.541**	−0.479**	−0.357
	(3.17)		(2.01)	(2.09)	(0.99)
Age	−0.023		−0.044*	−0.037	0.057*
	(1.13)		(1.68)	(1.51)	(1.79)

Table 8 (*continued*)

Panel B—Dep. Var.: Unused LC-to-cash	(6)	(7)	(8)	(9)	(10)
Industry concentration				1.444	0.717
				(0.42)	(0.18)
Industry interest coverage				−0.002*	−0.002**
				(1.85)	(2.01)
Industry capacity utilization				0.977	1.062
				(0.97)	(0.91)
Industry Q				−0.001	0.001
				(0.01)	(0.12)
Constant	0.148	0.244***	0.428***	−0.330	−0.580
	(1.38)	(4.22)	(4.52)	(0.40)	(0.62)
Cluster	Firm	Industry	Industry	Industry	Industry
Industry dummies?	Yes	No	No	No	No
Year dummies?	Yes	Yes	Yes	Yes	Yes
Specification	OLS	OLS	OLS	OLS	Tobit
Observations	1,903	900	900	900	900
R^2	0.37	0.10	0.39	0.40	0.36

corporate financial policies, with an emphasis on the management of liquid instruments such as cash and lines of credit.

Appendix A. Proof of Proposition 1

Suppose condition (7) holds. To prove the proposed equilibrium, let us analyze what happens in each state at date 1, given the proposed liquidity policies. Then we will show that firms do not benefit from deviating from the optimal liquidity policies at date 0.

In state $(1-\lambda)^2$, both firms continue since they do not need additional liquidity. In state $(1-\lambda)\lambda$, only firm L has a liquidity shock, and it is liquidated. Firm H continues, but does not bid for L. In state $\lambda(1-\lambda)$, only firm H has a liquidity shock. It can finance its liquidity shock and continues. Finally, in state λ^2, both firms have a liquidity shock. Firm H can continue, while firm L is liquidated.

These strategies generate enough date-0 pledgeable income for investors, so that projects can start. Consider first firm L. It makes $K_0^L = I - A_L$ (so that it can finance the initial investment), $K_{1,\lambda}^L = -\tau$ (liquidation or merger proceeds are fully pledged to external investors), and a payment $K_{2,(1-\lambda)}^L$ such that investors break even from the perspective of date 0. This payment must be such that

$$I - A_L = (1-\lambda) p_G K_{2,(1-\lambda)}^L + \lambda\tau. \tag{33}$$

Eq. (5) guarantees that we can find a $K_{2,(1-\lambda)}^L$ such that $p_G K_{2,(1-\lambda)}^L \le \rho_0$, thereby satisfying the pledgeability constraint.[41]

Firm H's optimal investment policy is to start its own project at date 0 and reinvest ρ in state λ at date 1 (so that it continues until the final date). In order to support this policy, firm H borrows sufficient funds to start the project at date 0 ($K_0^H = I - A_H$), and receives an additional payment of ρ from external investors in state λ ($K_{1,\lambda}^H = \rho$). It promises a date-2 payment K_2 (in both states), so that investors break even. This payment is such that

$$I - A_H + \lambda\rho = p_G K_2. \tag{34}$$

Eq. (6) guarantees that this payment satisfies the pledgeability constraint.

Are these strategies optimal given the other firm's strategy? By condition (4), it is efficient for both firms to withstand the liquidity shock. Firm L would benefit from saving more liquidity to withstand its own shock, but it is constrained by its low net worth A_L (condition (5)). Formally, since $\rho_0 - \lambda\rho < I - A_L$, one cannot find a date-2 payment $K_2^L \le \rho_0/p_G$ such that $I - A_L + \lambda\rho = p_G K_2^L$.

Firm H could deviate from the equilibrium strategy by bidding for firm L. However, condition (7) implies that it does not pay for firm H to deviate. H needs to pay a minimum price of τ to firm L's investors, and finance L's liquidity shock, ρ. Because the maximum that it can generate out of firm L's assets is $\rho_1 - \delta$, bidding is not profitable for firm H. Thus, no firm benefits from deviating from the equilibrium strategies.

Now suppose condition (8) holds. Given the proposed financial policies, in state λ^2 firm H would benefit from bidding for the assets of firm L, but does not have enough liquidity to finance the bid. In state $(1-\lambda)\lambda$, firm H does not have a liquidity shock, and uses its liquidity $\rho + \tau$ to bid for the assets of firm L. Given (8), the liquidity merger is efficient since firm H can generate $\rho_1 - \delta$ from the assets of firm L. Firm H pays the liquidation value τ to firm L's investors, and assumes the other liabilities of L (the liquidity shock ρ). The outcomes in the other states are identical to those above.

We now show that firms have sufficient pledgeable income to support the equilibrium strategies. The analysis for firm L is identical to that above. Firm H must have enough liquidity to withstand its own liquidity shock in state λ. This equilibrium requires that $K_{1,\lambda}^H = \rho$, and $K_{1,(1-\lambda)\lambda}^H = \rho + \tau$. Notice also that since firm H is acquiring firm L, as long as $\rho_0 - \delta > 0$, its pledgeable income will

[41] The financial policy is generally not unique. For example, the firm can also set $K_{1,\lambda}^L > -\tau$, and increase $K_{2,(1-\lambda)}^L$ (as long as the pledgeability constraint is satisfied).

increase in state $(1-\lambda)\lambda$. The break-even constraint in this case is

$$I-A_H+\lambda\rho+(1-\lambda)\lambda(\rho+\tau) \\ =(1-\lambda(1-\lambda))p_G K_2^* + \lambda(1-\lambda)p_G K^H_{2,(1-\lambda)\lambda}. \quad (35)$$

By Eq. (6), we can find a solution such that $p_G K_2^* \leq \rho_0$, and $p_G K^H_{2,(1-\lambda)\lambda} \leq 2\rho_0-\delta$. Thus, firm H can finance both its own liquidity shock, and also the liquidity merger.

Firm L cannot deviate from the equilibrium strategy since it does not have enough pledgeable income to withstand the liquidity shock (as above). Firm H would benefit from hoarding additional liquidity to bid for the assets of firm L in state λ^2, but it is constrained by date-0 pledgeable income as we show now. If firm H deviates and demands enough liquidity to bid for firm L also in state λ^2, it would require a transfer $K^H_{1,\lambda^2}=K^H_{1,(1-\lambda)\lambda}=\rho+\tau$. Thus, in order for investors to break even at date 0, we would require

$$I-A_H+\lambda\rho+(1-\lambda)\lambda[\rho+\tau-(\rho_0-\delta)]+\lambda^2[\rho+\tau-(\rho_0-\delta)] \leq \rho_0, \quad (36)$$

which violates (6). Thus, the proposed strategies are optimal given the pledgeability constraints.

Appendix B. Proof of Proposition 2

Let us first derive C and D_0^c, the optimal cash balance and debt level in the equilibrium without a liquidity merger. Eqs. (13) and (14) imply that

$$C=\frac{I-A_H+\rho-\rho_0}{(1-\xi)(1-\lambda)-\xi}, \quad (37)$$

and

$$D_0^c=\frac{\rho_0-\rho+(1-\xi)C}{p_G}. \quad (38)$$

This solution is feasible as long as $p_G D_0^c \leq \rho_0$, which implies the following constraint:

$$I-A_H+\frac{\lambda+\xi(1-\lambda)}{1-\xi}\rho \leq \rho_0. \quad (39)$$

Not surprisingly, this constraint becomes tighter as the cost of holding cash increases. If $\xi=0$, we have the same feasibility condition as in the security-design case (Proposition 1), which is always obeyed by condition (6). The parameter $\xi_{NM}^{\max}$ can be defined as the maximum cost of cash that is consistent with condition (39). Finally, given that creditors break even, firm H's payoff is given by the project's total value minus the cost of carrying the cash balance C (Eq. (16)), provided that $\xi < \xi_{NM}^{\max}$.

Let us move now to the equilibrium with a liquidity merger. C^M must fund both the liquidity shock in state λ, and the liquidity merger. Thus, we must have

$$(1-\xi)C^M+\rho_0-p_G D_0^M \geq \rho, \quad (40)$$

$$(1-\xi)C^M+2\rho_0-\delta-p_G D_0^M \geq \rho+\tau. \quad (41)$$

Finally, the debt level D_0^M must satisfy $p_G D_0^M \leq \rho_0$.

Notice first that since (C^M, D_0^M) must obey the same constraints as in the equilibrium with no liquidity merger, we must have $C^M \geq C$, and $D_0^M \geq D_0^C$. If this was not the case, then C and D_0^C would not be the optimal cash/debt combination in the equilibrium with no mergers. The firm has incentives to minimize the amount of cash that it carries, and thus, we know that C and D_0^c are the lowest amounts of cash and debt that satisfy the constraints in the equilibrium with no liquidity merger.

We now show that when condition (15) holds, we must have $C^M > C$. Suppose for contradiction that $C^M=C$, and $D_0^M=D_0^C$. Since condition (15) holds, the firm needs to use some of its cash to finance the liquidity merger. Formally, if we let y be the minimum amount of funds that the firm needs to use in state $(1-\lambda)\lambda$:

$$y+2\rho_0-\delta-p_G D_0^C=\rho+\tau, \quad (42)$$

then it is clear that when condition (15) holds, $y>0$. Thus, the firm returns only $(1-\xi)C-y$ to date-0 investors in this state. Investors' date-0 break-even constraint would then require

$$p_G D_0^C+(1-\lambda)^2(1-\xi)C+(1-\lambda)\lambda[(1-\xi)C-y]=I-A_H+C, \quad (43)$$

which cannot hold by Eq. (14) (which is equivalent to (43), for $y=0$). In order for Eq. (43) to hold, the amount of debt D_0 must increase from D_0^C to $D_0^C+\varepsilon$. But then, Eq. (40) would require

$$(1-\xi)C+\rho_0-p_G[D_0^C+\varepsilon] \geq \rho. \quad (44)$$

This cannot hold, since $(1-\xi)C+\rho_0-p_G D_0^C=\rho$. Thus, the firm must save an amount of cash that is greater than C. In equilibrium, we must then have that $C^M > C$, and $D_0^M > D_0^C$. In addition, the firm uses as little cash as possible in state $(1-\lambda)\lambda$. If we let y^M represent this minimum amount of cash that the firm needs to use, then the equilibrium is defined by

$$y^M+2\rho_0-\delta-p_G D_0^M=\rho+\tau, \quad (45)$$

$$(1-\xi)C^M+\rho_0-p_G D_0^M=\rho, \quad (46)$$

$$p_G D_0^M+(1-\lambda)^2(1-\xi)C^M+(1-\lambda)\lambda[(1-\xi)C^M-y^M]=I-A_H+C^M. \quad (47)$$

This solution is feasible as long as $p_G D_0^M(\xi) \leq \rho_0$, where we expressed the optimal debt level as a function of the cost of carrying cash. Since $D_0^M \geq D_0^C$, this condition is less likely to hold for the same cost of carrying cash ξ, and thus, if we let $\xi_M^{\max}$ denote the maximum possible cost of cash, we must have that $\xi_{NM}^{\max} \geq \xi_M^{\max}$. The firm's payoff is reduced by ξC^M, as long as $\xi < \xi_M^{\max}$. This completes the proof of the proposition.

Appendix C. Proof of Proposition 3

The analysis of the case without the liquidity merger is in the text. In the equilibrium with the merger, the credit line $w_{\max}^{LC}$ must satisfy Eq. (23), and also be sufficient to finance the liquidity shock in state λ (if the line is not revoked):

$$w_{\max}^{LC}+\rho_0-p_G D_0^{LC} \geq \rho. \quad (48)$$

Thus, in the liquidity-merger equilibrium, the total size of the credit line depends on the firm's relative need for precommitted financing in states λ and $(1-\lambda)\lambda$. If we define the amount by which the firm expects to use the credit line in state λ as

$$w_{\lambda}=\rho+p_G D_0^{LC}-\rho_0, \tag{49}$$

and the amount by which the firm expects to use the credit line in state $(1-\lambda)\lambda$ by

$$w_{(1-\lambda)\lambda}=\max[\rho+\tau+p_G D_0^{LC}-2\rho_0+\delta,0], \tag{50}$$

then the optimal size of the credit line is given by the maximum of these two values:

$$w_{\max}^{LC}=\max(w_{\lambda},w_{(1-\lambda)\lambda}). \tag{51}$$

A credit line of size $w_{\max}^{LC}$ ensures that the firm has enough liquidity to finance both its own liquidity shock, and also the liquidity merger. Notice that while w_{λ} is always greater than zero, $w_{(1-\lambda)\lambda}$ might be equal to zero.

As in the no-merger equilibrium, the firm finances the credit line by paying the commitment fee in the state in which the credit line is not used (state $(1-\lambda)^2$):

$$\lambda(1-q)w_{\lambda}+(1-\lambda)\lambda w_{(1-\lambda)\lambda}=(1-\lambda)^2 x^M, \tag{52}$$

where x^M (the commitment fee in the liquidity-merger equilibrium) must be lower than the firm's pledgeable income in state $(1-\lambda)^2$, that is, $x^M \le \rho_0-p_G D_0^{LC}$. This implies the following feasibility constraint:

$$I-A_H+\lambda(1-q)\rho+(1-\lambda)\lambda(\rho+\tau-\rho_0+\delta)\le(1-\lambda q)\rho_0+\lambda q\tau. \tag{53}$$

This inequality is implied by assumption (6), so that the credit line is always feasible. Thus, the credit line is always feasible in both equilibria.

As in the no-merger equilibrium, the main cost of the credit line is that it can be revoked in state λ. The firm's expected payoff is then given by Eq. (24).

Appendix D. Endogenizing line of credit revocability

The analysis of line of credit implementation in Section 3.2.2 takes the probability q as an exogenous parameter. We now show that this probability can be endogenized in a framework in which the probability of the liquidity shock λ is partly determined by managerial actions. For that purpose, we add another date to the model between date 0 and date 1 in which the manager must choose between two actions. The good action produces a probability of the date-1 liquidity shock equal to λ_G, and the bad action produces a probability $\lambda_B>\lambda_G$, but a private benefit equal to B_0 for the manager. The optimal contract must be designed to induce the good action.

Denote the manager's continuation utilities following the realization of the liquidity shock by U_{λ} (if the firm is hit with the liquidity shock), and $U_{1-\lambda}$ (if the liquidity shock does not occur). Then, the manager's incentive constraint requires that

$$(1-\lambda_G)U_{1-\lambda}+\lambda_G U_{\lambda}\ge(1-\lambda_B)U_{1-\lambda}+\lambda_B U_{\lambda}+B_0, \tag{54}$$

which implies that

$$U_{1-\lambda}-U_{\lambda}\ge\frac{B_0}{\lambda_G-\lambda_B}. \tag{55}$$

In order to induce the manager to take the right action, the optimal credit line must ensure that the manager's continuation utility depends on whether the liquidity shock is realized or not. As we now show, revoking the credit line in state λ allows the credit line to satisfy condition (55).

Consider first the equilibrium without the liquidity merger. In that case, the continuation utilities for H's manager are

$$U_{1-\lambda}=\rho_1-p_G D_0^{LC},$$

$$U_{\lambda}=(1-q)(\rho_1-p_G D_0^{LC}). \tag{56}$$

At date 1, the initial investment I is sunk and thus does not need to be considered. In the line of credit implementation of Section 3.2.2, the manager pays for the liquidity shock in state λ by raising capital from date-1 investors and the credit line. Thus, the manager's payoff at that point is equal to the project's total expected payoff, minus what was promised to date-0 investors. Finally, if the firm is liquidated (with probability q), the manager receives a zero payoff. We conclude that to induce managerial behavior, the probability q must satisfy

$$q^*=\frac{B_0}{\lambda_G-\lambda_B(\rho_1-p_G D_0^{LC})}>0. \tag{57}$$

Notice that the probability that the credit line is revoked is as low as possible to minimize liquidation costs.

The analysis is similar for the liquidity-merger equilibrium. The main difference is that the continuation utility in state $(1-\lambda)$ is higher than $U_{1-\lambda}$ due to the expected payoff from the merger:

$$U_{1-\lambda}^M=\rho_1-p_G D_0^{LC}+\lambda(\rho_1-\rho_0). \tag{58}$$

To understand this expression, notice that the merger happens with probability λ (the probability that L is distressed). If the merger happens, it produces total expected cash flows equal to $\rho_1-\delta$, and pledgeable cash flows equal to $\rho_0-\delta$, which are entirely used by the manager to finance the required investment of $\rho+\tau$ (and in addition, the manager may use the credit line). Thus, the manager's expected payoff from the merger is equal to $\lambda(\rho_1-\rho_0)$. The expression for $U_{1-\lambda}^M$ implies that the expression for q is now

$$0<q^M=\frac{\frac{B_0}{\lambda_G-\lambda_B}-\lambda(\rho_1-\rho_0)}{\rho_1-p_G D_0^{LC}}<q^*. \tag{59}$$

Notice that the line of credit can be revoked less often in the liquidity-merger equilibrium, because the possibility of acquiring firm L (which happens only in state $(1-\lambda)$) improves managerial incentives.

Appendix E. Proof of Proposition 4

Cash implementation is always feasible when $\xi=0$ and it is not feasible when $\xi=1$ (see Eq. (39)) so $\xi_{NM}^{\max}>0$. If $\xi>\xi_{NM}^{\max}$, the firm cannot use cash and will prefer the credit line (recall that the credit line is always feasible). If $\xi<\xi_{NM}^{\max}$, cash implementation is feasible. If $\xi=q=0$, then the firm is indifferent between cash and the credit line, so that $q_{NM}(0)=0$. Now, take a $q'>0$. For ξ small enough, the firm prefers cash to the credit line if $q=q'$, because of the expected loss from the revocability of the credit line, $\lambda q'(\rho_1-\rho-\tau)$. As ξ increases, U_H^{NC} decreases monotonically until the point at which $\lambda q'(\rho_1-\rho-\tau)=\xi' C(\xi')$, such that the firm is again indifferent between cash and credit lines. We can then define $q_{NM}(\xi')=q'$. A similar procedure will produce the cost of cash ξ that makes the firm indifferent between cash and credit lines, for all $q \le 1$. Clearly, $q'_{NM}(\xi) \ge 0$.

Appendix F. Proof of Proposition 5

The proof of the existence of the function $q_M(\xi)$ is identical to the proof above. For all $q \le 1$, we take the value of ξ that makes the firm indifferent between cash and the credit line. Clearly, $q'_M(\xi) \ge 0$. To show that $q_M(\xi) \ge q_{NM}(\xi)$, take again $q=q'$ as above. The cost of cash that makes the firm indifferent can be defined as $\lambda q'(\rho_1-\rho-\tau)=\xi'' C^M(\xi'')$. Since $C^M > C$, and $\partial \xi C^M(\xi)/\partial \xi > 0$, it must be that $\xi'' < \xi'$. Since the same point holds for all $q \le 1$, we must have that $q_M(\xi) \ge q_{NM}(\xi)$ (see Fig. 1).

Appendix G. Combining cash and credit lines (Section 4.1)

Denote by C^J the amount of cash that the firm would need to hold in such a joint policy, and by D^J the associated promised repayment at date 2. Let the credit line be big enough such that the firm can finance the bid for the other firm using the line. It only pays for the firm to deviate from the line of credit-only policy if it saves enough cash to survive the liquidity shock in state λ with probability 1. Since the line of credit will not be available in some states of the world, this condition requires

$$(1-\xi)C^J+\rho_0-p_G D^J=\rho. \tag{60}$$

The promised payment must in turn satisfy

$$p_G D^J = I-A_H+\lambda C^J+(1-\lambda)\xi C^J+(1-\lambda)\lambda[\rho+\tau-\rho_0+\delta] \le \rho_0. \tag{61}$$

Notice that the firm uses cash to withstand the liquidity shock, and the credit line to pay for the liquidity merger. This means that the firm can return $(1-\xi)C^J$ to investors in state $(1-\lambda)$. The line of credit-cash joint policy implies the following payoff:

$$U_H^J = U_H^M - \xi C^J. \tag{62}$$

The joint policy dominates the line of credit-only policy if it is feasible, and if the cost of carrying cash ξC^J is lower than the expected loss from revocability, $\lambda q(\rho_1-\rho-\tau)$. The cash balance C^J is higher than in an equilibrium with no mergers, because the firm must take into account that opening the line of credit will cost some debt capacity for the firm in state λ. However, the required cash balance is generally lower than C^M, given that the firm does not need to save additional cash with the specific purpose of financing the liquidity merger. Thus, it is possible that this joint policy dominates a line of credit-only in the liquidity-merger equilibrium.

Allowing for the possibility of a joint policy does not change the conclusion that the firm is more likely to use lines of credit in the liquidity-merger equilibrium. Consider the region in which $q < q_{NM}(\xi)$. For these parameter values, the firm chooses the line of credit in both equilibria. In particular, this implies that the cost of carrying cash ξC is higher than the expected loss from revocability, $\lambda q(\rho_1-\rho-\tau)$ in that region. Thus, the firm will not find it optimal to implement the joint policy in this region, even in the equilibrium with liquidity mergers. As derived above, the cost of carrying cash in such a case is $\xi C^J > \xi C$, which is necessarily larger than the expected loss from revocability. We conclude that the joint policy can only be optimal if $q > q_{NM}(\xi)$, which is the region in which cash is optimal in the equilibrium with no liquidity mergers.

Appendix H. Multi-firm setting

We now show that in the multi-firm setting described in Section 4.6, the probability of a liquidity merger goes down relative to the two-firm case analyzed above. We also show that the model's key result continues to hold. That is, firm H is more likely to use credit lines in the liquidity-merger equilibrium.

As we discuss in Section 4.6, the key difference in the model set-up is that the probability that an individual firm H that has high liquidity (that is, a firm H that is in state $1-\lambda$ and does not need to finance a liquidity shock) will find a financially distressed target goes down from λ to λ'. Proposition 1 (which describes the equilibrium under state-contingent contracting) continues to hold. If condition (7) holds, liquidity mergers are not profitable and all firms follow the same strategies that are described in the proposition. If condition (8) holds, then liquidity mergers will happen. Since liquidity shocks are idiosyncratic, in every state of the world there will be $(1-\mu)\lambda$ firms that are in need of a liquidity infusion, and $\mu(1-\lambda)$ potential acquirers. Distressed firms are randomly allocated to potential acquirers, who, conditional on finding a potential target, demand the same liquidity as they needed in the benchmark model. If a potential acquirer does not find a distressed target (probability $1-\lambda'$), it returns funds to investors such that investors break even. The date-0 expected payoffs in the equilibrium with no liquidity merger are identical to those described in Eq. (9), while the date-0 expected payoffs in the liquidity-merger equilibrium are

$$U_H^M=(1-\lambda)[(1-\lambda')\rho_1+\lambda'(2\rho_1-\rho-\delta-\tau)]+\lambda(\rho_1-\rho)-I \tag{63}$$

and

$$U_L=(1-\lambda)\rho_1+\lambda\tau-I. \tag{64}$$

The implementation of the no-liquidity-merger equilibrium using cash and credit lines is identical to that described above. In the liquidity-merger equilibrium, firms of type H must now take into account the fact that the probability of a liquidity merger is equal to λ'.

We now show that we must have $C^M > C'$, that is, the firm needs to save less cash than in the two-firm case. If we let y' represent the minimum amount of cash that the firm needs to use to help fund the liquidity merger, then the equilibrium is defined by

$$y'+2\rho_0-\delta-p_G D'_0=\rho+\tau, \tag{65}$$

$$(1-\xi)C'+\rho_0-p_G D'_0=\rho, \tag{66}$$

$$p_G D'_0+(1-\lambda)(1-\lambda')(1-\xi)C^M+(1-\lambda)\lambda'[(1-\xi)C'-y'] \\ =I-A_H+C'. \tag{67}$$

Since $\lambda'<\lambda$, a comparison of these equations with (45)–(47) shows that Eq. (67) can be satisfied by a lower debt level ($D'_0<D_0^M$), since the firm returns more cash to the bank in expectation $\lambda'<\lambda$. In turn, since $D'_0<D_0^M$, Eq. (66) implies that $C^M>C'$. This implies that the firm's payoff is higher than in the benchmark case in the cash implementation solution.

Financing the liquidity merger with the credit line is almost identical to the benchmark model. Firm H must have enough liquidity to finance the bid for firm L, if a target shows up. This requires

$$w_{\max}^{LC}+2\rho_0-p_G D_0^{LC}-\delta\geq\rho+\tau, \tag{68}$$

which is the same as the condition above. Firm H finances the credit line by paying the commitment fee in states in which the credit line is not used (probability $(1-\lambda)(1-\lambda')$). This implies the following feasibility constraint:

$$I-A_H+\lambda(1-q)\rho+(1-\lambda)\lambda'(\rho+\tau-\rho_0+\delta)\leq(1-\lambda q)\rho_0+\lambda q\tau. \tag{69}$$

This inequality is implied by condition (6), so that the credit line is always feasible. The main cost of the credit line is that it can be revoked in state λ. The firm's expected payoff is then given by Eq. (24), as in the benchmark model.

Thus, using cash to implement the liquidity-merger equilibrium increases the firm's payoff, while using a credit line results in an identical payoff to that of the benchmark case. We conclude that the firm is relatively more likely to use cash in this multi-firm extension. More formally, there exists a function $q(\xi)$, satisfying $q'(\xi)\geq 0$ and $q(0)=0$, such that if $q>q(\xi)$, the firm prefers cash to lines of credit and if $q<q(\xi)$, the firm prefers lines of credit to cash. Finally, it must be that $q_M(\xi)\geq q(\xi)$. In terms of Fig. 2, $q(\xi)$ will lie between $q_M(\xi)$ and $q_{NM}(\xi)$. Although qualified in this context, our model's main results continue to hold.

Appendix I. Pooling idiosyncratic risk in credit line provision

As discussed in Section 3.2.2, a key feature of the credit line is that it can be provided to the firms at an actuarially fair cost. In order for this to be the case, a financial intermediary must be able to fund the demand for credit line drawdowns without holding cash in the balance sheet. Since holding cash is costly, the intermediary would then have to charge higher commitment fees to break even.

In this section we prove that under the assumptions of our model, a financial intermediary can indeed provide credit lines at an actuarially fair cost. The key to this result, as explained by Holmstrom and Tirole (1998) and Tirole (2006), is the intermediary's ability to pool liquidity risks across firms.

In order to show this point, consider the same set-up of Section 4.6. There are several firms of types L and H, of total measure equal to one. The fraction of firms of type H is equal to μ. Firms of type L do not demand liquidity. If firms of type H suffer a liquidity shock (state λ), they draw on the credit line and fund the shock. If they do not suffer a shock (state $1-\lambda$), then they have a probability equal to λ' to acquire a firm of type L. In that case, they make additional drawdowns on their credit line.

Under the assumptions of the model, both types of firms have enough pledgeable income to finance these strategies, that is:

$$I-A_L\leq(1-\lambda)\rho_0+\lambda\tau \tag{70}$$

and

$$I-A_H\leq(1-\lambda)(1-\lambda')\rho_0-(1-\lambda)\lambda'[\rho+\tau-(2\rho_0-\delta)]-\lambda(\rho-\rho_0). \tag{71}$$

Since $\lambda'<\lambda$, it is straightforward to show that these pledgeability conditions are implied by conditions (5) and (6).

Now, consider the financial intermediary's pledgeability constraint. The intermediary provides financing to all firms in the model, and uses payments from liquid firms to fund credit line drawdowns by firms of type H. Since liquidity shocks are idiosyncratic, all states of the world are identical. In each state, there are $\mu\lambda$ firms of type H who draw on the credit line to fund the liquidity shock, and $\mu(1-\lambda)\lambda'$ firms of type H who draw on the line to fund the liquidity merger. There are $\mu(1-\lambda)(1-\lambda')$ firms of type H who do not need liquidity and return pledgeable income to the bank. In addition, no firms of type L demand liquidity. $(1-\mu)\lambda$ firms of type L get liquidated or acquired (producing pledgeable income equal to τ), and $(1-\mu)(1-\lambda)$ firms produce pledgeable income equal to ρ_0. Thus, the bank's feasibility constraint requires that

$$\mu[\lambda(\rho-\rho_0)+(1-\lambda)\lambda'[\rho+\tau-(2\rho_0-\delta)]] \\ \leq\mu(1-\lambda)(1-\lambda')\rho_0+(1-\mu)\lambda\tau+(1-\mu)(1-\lambda)\rho_0 \tag{72}$$

This condition is implied by those in Eqs. (70) and (71), for any value of μ. Thus, the bank has enough pledgeable income flowing from liquid firms to fund credit line drawdowns, and does not need to hold capital (save cash) in its balance sheet.

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