# Bank Syndicates and Liquidity Provision

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**Abstract**

We provide a model where credit lines syndicates commit to provide liquidity. Our model yields predictions about the syndicate, pricing and the special role of the lead bank. Consistent with our model, we find that syndicate members with a relationship with the borrower make larger investments and are less likely to exit the syndicate. Lead banks offer a discount particularly on commitment fees to borrowers they have relationships with. Consistent with their unique role, lead banks are more likely increase their investments following the failure of syndicate members, although not enough to fully offset the lost commitment.

# 1 Introduction

Credit lines involve commitments to provide liquidity which was made clear by the wave of corporate drawdowns that followed the Covid-19 outbreak in the US. Between March 12 and April 9, 2020, 452 corporations drew $218 billion on their credit lines according to S&P LCD. 110 of those corporations experienced a credit downgrade or were put on rating agencies' watch list. Among these, the drawdown rate was 77% for those that accessed their credit lines before or on the day of rating agencies' action and 75% for those that did it afterwards (Figure 1).[1] While this is not a statistical test, it is related to the key point we want to make in this paper, that substantial liquidity is available to firms with outstanding credit lines under adverse circumstances. Even when loan syndicates are faced with liquidity provision shocks, they generally fulfill their commitments and allow firms to drawdown credit.

We provide a dynamic model of syndicate construction and show how syndicate profits are distributed across commitment fees and interest rates and how commitment fees are distributed between the lead and non-leads. We focus on the tension between risk sharing within the syndicate and the *ex post* limited commitment in providing liquidity insurance. We also pay particular attention to the distinction between the lead bank, that has other business relationships with the firm and has higher incentives to provide liquidity insurance *ex post*.[2] Our theory of syndicates yields a number of predictions which we test.

We assume that syndicate members receive supply shocks (possibly net worth shocks as in Holmstrom and Tirole (1997) and Rampini and Viswanathan (2019a)) making liquidity provision costly. Given these shocks, two problems arise which syndicates optimally resolve. First, the convex cost of liquidity provision when faced with supply shocks creates incentives to form a syndicate (optimal risk sharing). Second, limited commitment to provide liquidity when the borrower draws down and the syndicate faces a liquidity shock requires long run profits or other long run rents to ensure the incentive

[1] For the remaining 342 borrowers, the average drawdown rate was 62%.

[2] In syndicated credit line arrangements, the lead bank controls the relationship, often has other businesses with the firm and has a higher credit line share. Non-lead banks, or syndicate member banks have smaller shares. Lead banks tend be the large banks while non-leads are smaller regional or foreign banks. See Table 1 for descriptive details.

constraint for liquidity provision is not violated.

The supply shocks make the ex post provision of liquidity at the committed interest rate difficult because they increase syndicate members' ex post cost of capital. Offsetting this liquidity provision cost shock is the continuation value of the relationship with the firm to syndicate members, which varies across the lead and non-leads syndicate members. Following Ray (2002) and Board (2011), we design the optimal syndicate and show that it depends both on the cost of capital for syndicate members after the supply shock and on how much syndicate members discount the future and care for their relationship with the borrower.

Initially, we consider a model where only continuation value from lending to the borrower's credit line makes the incentive constraint hold. Here optimal risk sharing continues to hold but the credit line relationship must have rents (commitment fees or interest spreads) which are shared unequally between the lead and non-leads. Subsequently, we consider an extension where the lead bank has other relationships with the borrower that generates profits which would be lost if the liquidity provision does not occur. In this case, the incentive constraint for liquidity provision by the lead is relaxed and the lead takes a much bigger credit line share, violating optimal risk sharing. We argue that the heterogeneity in risk capacity and incentives across the lead and non-leads are critical in understanding the syndicate structure.

The first set of predictions pertains to the credit line syndicate. According to our model, larger loans will have larger syndicates, due to risk sharing incentives. Further, in the presence of shocks which make risk sharing more costly, the relationship between loan size and the syndicate size becomes stronger. Our model also highlights the importance that banks' relationships with the borrower has credit line syndicates. Specifically, it posits that banks will make larger investments in credit lines of borrowers with whom they have a relationship with. In addition, syndicate members with relationships with the borrower are less likely to exit syndicates during the life of the credit line.

The second set of predictions relates to the unique role lead banks play in the liquidity insurance afforded by credit lines. According to our model, the lead bank is more likely than non-leads to provide compensatory liquidity following the failure of a syndicate member bank, but it will not fully offset the effect of the failure. Surprisingly, on these instances leads with other relationships will provide less marginal liquidity as they are overexposed to the firm by virtue of their already high credit line share.

Lastly, our model yields some predictions about the pricing of credit lines. Our model posits that banks will charge higher commitment fees and lower spreads for borrowers with higher expected drawdown probabilities. Additionally, credit lines taken out when banks experience liquidity supply shocks will carry higher commitment fees. Further, lead banks will offer discounts mainly through commitment fees rather than spreads to borrowers with whom they have relationships with.

We test these predictions, capitalizing on data from the Shared National Credit (SNC) program and Dealscan. The SNC program tracks syndicated credits annually and contains comprehensive information on syndicates, including members' loan shares. This allows us to observe if and when borrowers draw down on their credit lines, and when credit commitments experience cuts. It also allows us to investigate lead and non-lead banks' loan share decisions. Further, since the SNC program tracks both credit lines and term loans and our sample goes back to 1988 we are able to investigate the importance of banks' relationships with borrowers derived from previous lending experiences or from banks' funding term loans to the same borrowers in addition to credit lines. Because the program SNC does not contain pricing information, we resort to Dealscan which reports comprehensive data on commitment fees and spreads on credit lines.[3] We merge the two datasets to investigate the importance of borrowers' expected drawdowns on credit lines' prices. Additionally, we merge those two datasets with Call Reports (to get banks' balance sheet information), and with Compustat and CRSP (to get information borrowers' balance sheets and security returns data, respectively).

We find support for our model's predictions on credit line syndicates. Lead and non-lead banks with relationships with the borrower own larger shares of the borrower's credit line and are less likely to exit the syndicate during the life of the credit line. These findings are robust because we allow for credit-year fixed effects and also include bank-year fixed effects. Further, they hold both when we measure the relationship by the

[3]See Bord and Santos (2012) for a comparison between the SNC and Dealscan databases.

age of the lending relationship between the bank and the borrower and by the bank's investments in the borrower' outstanding term loans – a good proxy for our model's outside business between the bank and the borrower. We also find, consistent with our model, that larger credit lines have larger syndicates. Importantly, this relationship is strengthened for credit lines originated during recessions (our proxy for bank liquidity supply shocks), when it is arguably costlier to share liquidity risk.

Turning to the lead bank, we find empirical support for our model's prediction that the lead bank plays a unique role in the liquidity insurance offered by the credit line without fully insuring the borrower. When a syndicate member fails, the lead bank is more likely to increase its loan investment and to make larger additional investments when compared to the non-lead syndicate members. Interestingly, and in line with our model, on these occasions leads with relationships make relatively smaller additional investments. Notwithstanding the lead's additional efforts, the borrower still experiences a reduction in its credit line following the failure of a syndicate-member bank.

Finally, we find that credit lines originated during recessions carry both higher undrawn fees and all-in-drawn spreads (our proxies for the model's commitment fee and credit spread, respectively), with the effect being more pronounced on the fees. Interpreting recessions as periods where banks face higher liquidity provision costs in the future, this finding supports the model's insight that higher future liquidity cost provision will lead to higher commitment fees ex ante. Our results also show that borrowers benefit from a discount in both undrawn fees and all-in-drawn spreads, with a more pronounced effect on the fees, when they borrow from lead banks they have a lending relationship with. Also, consistent with our model we find that borrowers with an history of drawing down heavily on their credit lines – our proxy for their future drawdowns – pay higher undrawn fees on their future credit lines. However, contrary to our model we find that these borrowers also pay higher all-in-drawn spreads, a sign that past drawdown rates account for some credit risk not fully captured by our loan- and borrower-specific controls. It is nonetheless reassuring to see that past drawdown rates are associated with an increase in the ratio of the undrawn fee to the all-in-drawn spread for the same credit line, confirming that banks rely more on undrawn fees to capture the borrowers' liquidity risk,

Altogether, our empirical findings, in particular those on syndicate members' investments and exit decisions depending on the nature of their relationship with borrowers, and those on lead banks' responses following a syndicate member failure as well as our results on undrawn fees relative to credit spreads, provide strong support to our theory. This is because these results not only speak to predictions specific to our theory but also because they are all tightly derived.

Our theory is most closely related to the repeated game models considered in Ray (2002) and Board (2011). In particular, we follow Board (2011) in using the continuation value of the relationship as providing incentives to offset the limited commitment in servicing credit lines when the bank (or banks) receive liquidity shocks. We differ from this literature in that we consider not one lender or buyer or seller but rather a group of banks that come together in a syndicate to provide liquidity insurance. In doing so, we combine optimal (unequal) risk sharing with ex post limited commitment and provide a theory of syndicates where leads have a different role than non-leads.

Our approach is also related to the literature on net worth shocks to financial intermediaries pioneered by Holmstrom and Tirole (1997) and also considered in Rampini and Viswanathan (2019a). We differ from these models in that we model liquidity shocks as cost shocks that are heterogeneous across banks and focus on the structure of the credit line syndicate: the credit line shares, the division of commitment fees and interest rate spreads and the role of existing business relationships with the firm. As in these models, we focus on the limited commitment of providing the credit line when liquidity shocks to banks occur. In our model, the continuing relationship value of the firm to the syndicate or the outside relationship value to the lead are the source of credibility for credit line commitments.

Our paper contributes to the debate on the liquidity insurance provided by credit lines, in particular those studies that focus on the role of banks. A strand of this literature argues that banks' inability (or willingness) to supply funds hinders the liquidity insurance role of credit lines.[4] Acharya et al. (2013) point out that credit line use is

[4]Another strand of the literature, including Roberts and Sufi (2009), Sufi (2009) and Chodorow-Reich and Falato

subject to an aggregate liquidity risk because the banking sector is unable to meet the liquidity demands of the entire corporate sector. Consistent with this idea, Demiroglu et al. (2012) document that borrowers' access to credit lines is contingent on the banking sector's lending standards, and Huang (2010) finds that credit lines of more distressed banks at the beginning of the crisis experienced lower utilization rates. Borrowers appear to be aware of these risks. Ivashina and Scharfstein (2010) document an increase in drawdowns during the second half of 2008 and note that in several instances firms state the drawdowns were to enhance their liquidity. Similarly, banks appear to factor in their exposures to the credit lines they granted. Berrospide (2012) find that large unused commitments were a key determinant of increased precautionary liquid buffers that large US banks built during the 2008-09 financial crisis. Greenwald et al. (2023) find that banks reduced lending to smaller firms following the increased drawdowns by large corporations during the Covid-19 consistent with credit lines providing liquidity for large firms. More recently, Donaldson et al. (2024) argue that the bundling of credit lines with loans is a way to commit to not issue new debt and limit debt dilution, providing a different rationale for the bundling of credit lines and loans.

Despite the importance of banks evidenced in these studies and the fact that most credit lines for mid-sized and large firms are granted through bank syndicates, surprisingly the literature on the role syndicates play on credit lines' liquidity insurance is rather scant. A notable exception is Paligorova and Santos (2019) who document that credit lines granted by syndicates of riskier banks tend to have lower drawdown rates and are more likely to experience reductions, consistent with them providing lower liquidity insurance.[5] Our paper adds to this body of empirical research by identifying a set of novel factors which are important to understand the liquidity insurance role of credit lines, including the size of the syndicate, the relationships syndicate members have with the borrower, and the unique role of the lead bank.

(2018), argues that credit lines' liquidity insurance role is contingent on borrowers' performance. See Flannery and Lockhart (2009), Yun (2009), Campello et al. (2010), Campello et al. (2011), Lins et al. (2010), and Acharya et al. (2012) for other studies arguing that cash and credit line availability are not good substitutes.

[5]There is a sizable literature on lead banks' loan shares but its focus has been on whether lead banks monitor borrowers. See Sufi (2007), Ivashina (2009), Focarelli et al. (2008), Gustafson et al. (2021), Plosser and Santos (2018), Blickle et al. (2020) and Glaser and Santos (2020).

Our paper also adds to the literature on credit lines' pricing. A branch of this literature, including Shockley and Thakor (1997), Chava and Jarrow (2008), Gatev and Strahan (2006) and Bord and Santos (2014), focuses on commitment fees. Another branch, including Berg et al. (2017) and Plosser and Santos (2024), focuses on credit spreads. We expand the former studies by documenting that banks factor in borrowers' drawdown past experiences when they set the commitment fees on their credit lines. Additionally, we expand this literature by showing that long-term relationships with lead banks translate in both lower fees and spreads. Importantly, we document the effect is more pronounced on fees, likely because lead banks have more discretion over these than credit spreads which are more market driven.

The rest of the paper is organized as follows. Section 2 discusses our theory and its implications. Section 3 discusses the data we use, and characterizes our sample. Section 4 provides the empirical evidence in support of our model while Section 5 concludes.

## 2 A Theory of Credit Line Syndicates

We develop a model where credit lines provide liquidity insurance. We assume that borrowers value liquidity insurance and that banks face higher liquidity provision costs during crisis (as, for example, in Rampini and Viswanathan (2019a) where there is a net worth shock to financial intermediaries). The model is intended to offer a better understanding of how incentive compatible syndicates are formed, and how syndicate shares are assigned, two important questions in understanding credit line syndicates that have not been considered in the prior literature. We pay particular attention to the asymmetry between the lead bank and non-lead syndicate members, both in risk sharing and incentive provision. Our first model considers heterogeneity in risk sharing across the syndicate while the extension allows for both heterogeneity in risk sharing and incentive provision. We use both variants of the model to derive empirical predictions which we test in the Section 4.

## 2.1 The Borrower

We consider a setup where a borrower wishes to obtain a credit line at variable interest rate $R > r$ where $r$ is the underlying benchmark rate for that risk class. We assume that the amount of the loan commitment is $L$, lasts for one period, and the probability of a drawdown is $p$. The borrower pays the flat rate $R$ on the amount it draws, which is independent of any bank liquidity event; this offers partial insurance against any ex-post variations in bank liquidity costs. In addition, the borrower pays a one time commitment fee, $C$, when it obtains the credit line. Lastly, the credit line is provided by a syndicate of N banks. Thus, a loan commitment is a triple (R, C, N) where: C is the commitment fee, R is the interest rate, and N is the number of banks in the syndicate.

## 2.2 Liquidity Events and Lenders

Absent a liquidity event (which is an aggregate event), the cost of providing liquidity is $r$ and when liquidity events occur (which happens with probability $q$) the cost of providing funding of size $L$ is given by $r + m(L)$ where $m'(L) > 0$ and $m''(L) > 0$ (strictly convex funding function). Also, we assume that $m(0) = 0$ and $m'(0) = 0$. We assume that this liquidity event is systemic and is the same across all banks in the syndicate.[6]

Thus the syndicate receives a loan commitment fee $C$, and an interest $R$ if the loan commitment is exercised. It pays a normal cost of providing liquidity of $r$ and an additional cost of providing liquidity if a liquidity event occurs of $m(\frac{L}{N})L$ if there are $N$ members in the syndicate and a cost of creating and running the syndicate of $(N-1)x$ where $x$ is the incremental cost of adding a participant (these could represent coordination costs).

We are going to argue similarly to Holmstrom and Tirole (1997), Rampini and Viswanathan (2019b) and others that, *ex post*, the interest rate on the loan commitment may be too low for the loan commitment to be incentive compatible for the syndicate (the loan commitment fee is sunk at this point). Holmstrom and Tirole (1997) focus on the incentive issue of delivering the loan commitment in the cross section and argue

[6]It is clear that an idiosyncratic event that affects one bank does not matter; other banks can still provide liquidity at cost $r$. Only systemic events that affect all banks are relevant.

for a role for government bonds. Rampini and Viswanathan (2019b) focus on the general equilibrium and show that a collateral shortage in general equilibrium may reduce lending, increasing the cost today of a future loan commitment. Instead we focus on the institutional features of syndicates and the continuation value of the future firm relationship with syndicate members. We show that if that relationship has sufficient value, the syndicate will continue to make the loan commitment to the firm even when hit by liquidity shocks that increase the cost of supplying liquidity.

Let $\Pi$ be the profit of the whole syndicate. Then it will be defined by

$$\begin{aligned}\Pi &= C + pRL - p(1-q)rL - pq(r + m(\frac{L}{N}))L - (N-1)x \\ &= p(R-r)L + C - pqm(\frac{L}{N})L - (N-1)x. \end{aligned} \tag{1}$$

### 2.3 Credit Lines with No Syndicate Ex Post Incentive Constraints

We assume that the borrower has a profit function $\Pi^B(p(R-r)L, C)$ that is maximized at $(0,0)$, i.e. $\Pi^B(0,0) > \Pi^B(p(R-r)L, C)$ for all $C \geq 0$ and $R \geq r$. Further, we assume that the partial derivatives satisfy $\Pi^B_R(p(R-r)L, C) < 0$, $\Pi^B_C(p(R-r)L, C) = \Pi^B_C < 0$ and $\Pi^B_{RR}(p(R-r)L, C) < 0$. This implies that the borrower wishes to find $(R, C)$ that maximizes $\Pi^B(p(R-r)L, C)$ or equivalently minimizes

$$\left[\Pi^B(0,0) - \Pi^B(p(R-r)L, C)\right] = H(p(R-r)L) + G(C); \tag{2}$$

this is a well defined convex cost function with $H_R(p(R-r)L) > 0$ and $H_R(0) > G_C > 0$ and $H_{RR}(p(R-r)L) > 0$ and $G_{CC} = 0$.[7]

In a perfectly competitive market with no ex post constraints (first best) the maximization problem for the firm (or the equivalent cost minimization problem) is then given by

$$\min_{R,C,N} H(p(R-r)L) + G(C), \tag{3}$$

[7]This assumption is consistent with the idea that the borrower wishes to be insured and thus the cost of providing liquidity will be in the commitment fee and not in the interest rate under the first best solution. By considering a reduced form optimization problem for the borrower, we are focusing on the dynamics of the syndicate risk sharing and incentive provision.

such that

$$(\lambda_F) - pL(R-r) - C + pqm(\frac{L}{N})L + (N-1)x \leq 0; \tag{4}$$

$$(\mu) - R \leq -r$$

$$(\gamma) - C \leq 0 \tag{5}$$

where the first constraint is the positive profit (breakeven) constraint on banks. The other two constraints require that the interest rate charged be greater than $r$ and that the loan commitment fee be positive.

**Proposition 1.** *The first best syndicate size $N^*$ is determined by:*[8]

$$-pqm'(\frac{L}{N^*})\frac{L^2}{(N^*)^2} + x = 0 \tag{6}$$

*which increases in $L$, the loan commitment size. Further, if $H_R(0) > G_C > 0$, which we will assume throughout the paper, we have that $C > 0$ and $R = r$; it is cheaper to put the cost of providing the first best loan commitment in the commitment fee rather than the interest rate and thus the interest rate will be $r$.*[9] *The first best commitment fee is:*

$$C = pqm(\frac{L}{N^*})L + (N^* - 1)x. \tag{7}$$

The first best solution will not be ex post incentive compatible if a liquidity event occurs. When a liquidity event occurs, the marginal cost of providing liquidity is given by $r + m(\frac{L}{N})$, which must be less than the commitment interest rate $R$. Ex post, the commitment fee is sunk. Hence, ex post incentive compatibility requires that

$$R = r > r + m(\frac{L}{N}) \tag{8}$$

which is not true; thus, the credit line provides no liquidity insurance given the incentive constraint.

[8]We are treating the number of members in the syndicate as a real number for simplicity so as avoid issues with discrete entry.

[9]Implicit in searching for solutions where $R = r$ in the first best (no incentive constraints) is the idea that the firm desires insurance in the interest rate against syndicate supply shocks and that the cost of providing liquidity insurance is in the commitment fee. In what follows, we will assume that this condition holds.

### 2.4 The Syndicate Ex Post Incentive Constraint and Relationship Lending

We now extend our model to consider the syndication process in a repeated game setting. As we will show, the repeated interaction of the syndicate with the firm can give rise to the appropriate incentives.

Consider a stationary game (from Ray (2002), the self-enforcing contract must be stationary). Let $\Pi$ represent the static per period profit of the syndicate. Then, a syndicate member will provide the loan commitment if the **ex post participation constraint** holds:

$$RL + \frac{\delta\Pi}{1-\delta} \geq rL + m(\frac{L}{N})L. \tag{9}$$

Equation (9) differs from Equation (8) by accounting for the discounted stream of profits that a syndicate member earns from the decision to participate. The long run profit from being in the syndicate in the future (the relationship value) is enough to make the ex post participation constraint bind. Implicit in this approach is that a syndicate member who defects loses the long run profit and is not a member of the syndicate going forward (the outside option is zero).[10]

This leads to the following incentive condition for a stationary game:

$$R \geq r + m(\frac{L}{N}) - \frac{\delta}{1-\delta}\frac{\Pi}{L}; \tag{10}$$

essentially, the interest rate charged has to be weakly greater than the marginal cost of financing minus the discounted long run profits earned by the syndicate. Thus, the syndicate has to make a positive profit when there are participation constraints, which implies the first best competitive equilibrium is not implementable. In the equilibrium, we construct (in the case where $R = r$), each syndicate will earn a small profit per period equal to $\frac{1-\delta}{\delta}m(\frac{L}{N})\frac{L}{N}$; the present value of these profits makes it incentive compatible for the syndicate to provide liquidity even when there are liquidity shocks to syndicates (events which occur over the life of the relationship with probability $pq$).[11] Our con-

[10]There could be harsher punishments; the lead could remove a non-lead who defects and does not provide liquidity from all syndicates in which the non-lead participates with that lead.

[11]Specifically, the per period profit of syndicate participants is given by $\frac{1-\delta}{\delta}[m(\frac{L}{N})] - (R-r)\frac{L}{N}$.

struction has similarities to Board (2011) in that delaying the rents to the syndicate over the life of the relationship allows the firm to receive liquidity not just the first time the shocks hits both firms and banks but for all such subsequent joint liquidity shocks. Thus the firm pays a rent equal to the extra *ex post* cost of providing liquidity when a liquidity shock hits the syndicate and the firm draws down liquidity; this one time rent spread over the future makes it incentive compatible for the syndicate to provide liquidity under stress not just for the first stress event but for all future stress events.[12]

### 2.5 The Repeated Game

We formally consider the repeated game and solve for the second best loan commitment $(R_t, C_t, N_t)$ for all $t$. Following Ray (2002), the optimal self enforcing contract that maximizes the firm payoffs must be stationary. Hence, we can write the firm's choice of contract given the ex post constraint on the bank as given by the problem:

$$\min_{R,C,N} H(p(R-r)L) + G(C), \tag{11}$$

such that

$$\begin{aligned} &(\lambda) \quad -(R-r)L\tfrac{1-(1-p)\delta}{1-\delta} - \tfrac{\delta}{1-\delta}\left[C - pqm(\tfrac{L}{N})L - (N-1)x\right] \leq -m(\tfrac{L}{N})L; && (12)\\ &(\mu) \quad -R \leq -r; && \\ &(\gamma) \quad -C \leq 0. && (13) \end{aligned}$$

Given this setup, the optimal syndicate structure has the following characteristics that we show in Proposition (2) next. First, the syndicate structure is efficient in that marginal cost of liquidity provision is the same across all syndicate members.[13] Hence, given the endogenous number of syndicate members (which is higher due to the incentive constraint), the total cost of providing liquidity is determined. Given this cost, the firm

[12] We note that if switching between syndicates is allowed and a new syndicate is allowed to make up front transfers to a switching firm and if the switching cost exceeds $\frac{1-\delta}{\delta}m(\frac{L}{N})$, in the equilibrium we construct, no switching will occur. This is because if the firms switches today, then the new syndicate will conjecture that it will also switch tomorrow and thus a new syndicate will only pay the one period profit as rent which is insufficient to make the firm switch. As Board (2011) discusses in the context of franchise relationships, such up front payments are not common in practice.

[13] With symmetry this is somewhat obvious, but with leads and non-lead syndicate members, this efficiency characterization will be important.

determines whether it prefers to pay only a commitment fee or an interest rate spread and a commitment fee.[14]

**Proposition 2.** *The optimal syndicate size ($\hat{N}$ in the second best) is given by*

$$pqm'(\frac{L}{N})\frac{L^2}{N^2} + \frac{1-\delta}{\delta}m'(\frac{L}{N})\frac{L^2}{N^2} = x; \tag{14}$$

*here $\hat{N} > N^*$ and as before $\hat{N}$ increases in $L$. Let $d = \frac{\delta}{1-\delta}$. If $\delta \in [\bar{\delta}, 1]$, then $\frac{H_R(0)}{G_C} > \frac{1}{pd} + 1$ (condition I) and $\hat{C} > C^*$ and $\hat{R} = r$. If $\delta \in [\underline{\delta}, \bar{\delta}]$, then $\frac{H_R(0)}{G_C} < \frac{1}{pd} + 1$ and $\hat{R} > r$. If $\frac{H_R(0)}{G_C} < \frac{1}{pd} + 1$ and $\frac{m(L/\hat{N})}{(\hat{R}-r)} > 1 + \max_t \frac{H_R(t)}{H_{RR}(t)t}$ (conditions II), then $\hat{R} > r$ and $\hat{C} > C^*$.*[15]

Thus dynamic incentive issues lead to a higher syndicate size and higher commitment fees. When the discount rate $\delta$ is close to one (little discounting), incentive compatibility obtains due to the present value of future commitment fees and the interest rate spread is zero. Essentially, the syndicate is able to provide insurance via the commitment fee. As the discount rate $\delta$ goes away from one (future is less valuable), the interest rate spread and the commitment fee will also be used, only partial insurance via the commitment fee can be offered.[16]

Define the total fees and expected spreads to the bank as $TC = p(R - r)L + C$. Using Proposition (2) we can show the following comparative statics:

**Proposition 3.** *Suppose either $p^+ > p$ or $q^+ > q$ or $\delta^+ < \delta$, then $\hat{N}^+ > \hat{N}$, the number of syndicate members goes up. If $p^+ > p$ or $q^+ > q$ then $\hat{C}^+ > \hat{C}$ and $\hat{T}C^+ > \hat{T}C$. If $\delta^+ < \delta$ and either of the conditions stated in Proposition 2 hold, then then $\hat{C}^+ > \hat{C}$ and $\hat{T}C^+ > \hat{T}C$. Hence the total commitment fees and total fees and expected spread always goes up. Further if the second condition (conditions II) in Proposition 2 holds*

[14] A commitment fee only is full insurance. An interest rate and a commitment fee has some characteristics of partial insurance as the interest rate is paid on drawdown.

[15] In the Appendix A, we show that the Conditions II holds for an interval $[\underline{\delta}, \bar{\delta}]$ via example. With very low discount rates, the value of future profits is very low and thus insurance via commitment fees is less plausible.

[16] Note that $m(\frac{L}{N}) > R - r$ since syndicate profits are positive. Conditions II in Proposition(2) say that if the cost function for the interest rate is convex enough, increasing the interest rate comes at a high cost and hence in this case both the interest rate and commitment fee are increased. See further discussion in Appendix A where we show that the Conditions II holds for a region $[\underline{\delta}, \bar{\delta}]$ via example. Essentially the firm desires to be insured against interest rate shocks sufficiently for conditions II to hold.

*(here $\hat{R} > r$), then if $p^+ > p$ then $\hat{R}^+ < \hat{R}$; increasing $q$ has no effect on $\hat{R}$ and if $\delta^+ < \delta$ then $\hat{R}^+ > \hat{R}$.*

Essentially, a higher probability of drawdowns or a higher probability of bank stress or syndicates caring less for the future (for example, due to a crisis, banks are weaker and care less for future profits) must lead to larger syndicates and higher commitment fees and higher total fees and spreads.[17] If we are in the region where $\hat{R} > r$ (and conditions II hold), an increase in the probability of drawdowns decreases the interest rate since insurance is now more valuable; if syndicates care less for the future the interest rate goes up (providing incentive commitments via future profits is harder) and an increased probability of bank stress has no effect on interest rates (it shows up in the commitment fee).

### 2.6 Syndicate Shares and Syndicate Profits

In practice, syndicate leads have higher shares and a different role from other syndicate members. To reflect this, we consider an extension where syndicate leads have greater ability to provide liquidity in a stressed state. In particular, we assume that the liquidity cost functions for the lead and non-leads are $m(L)$ and $n(L)$, respectively, with:[18]

$$\begin{aligned} m(0) = n(0) = 0; &\qquad m'(0) = n'(0) = 0; \\ m'(L) < n'(L); &\qquad m''(L) < n''(L) \qquad \forall L > 0. \end{aligned}$$

Hence the lead bank has greater ability to provide insurance in a liquidity event than non-leads. Nevertheless, diversification is valuable and lead banks will share the liquidity risk with non-lead banks. Given a total loan size of $L$, let $L_m$ be the lead share and $L_n$ be the total non-lead share. Also, let $C_m$ be the commitment fee given the lead and $C_n$ be the total commitment fee given to all the non-lead banks (and $C = C_m + C_n$ be the

[17] We are assuming in the model that $p$ is known and fixed. If we fix the syndicate size, we can allow for learning about $p$ from drawdowns since Equation (12) with $R = r$ implies a commitment fee that is linear in $p$ given fixed $N$; further Bayesian beliefs form a martingale. These two facts lead to a very similar dynamic model where $p$ is replaced by its expectation which changes over time in the case where $\hat{R} = r$, which needs $\frac{H_R(0)}{G_C} > \frac{1}{pd} + 1$.

[18] Note that our assumptions immediately imply that $m(L) < n(L)$. At times, we use the cost functions $m(L) = L^\psi$ and $n(L) = L^\gamma$, $\gamma > \psi > 1$. Here we need the additional restriction that $L_m \geq 1$ and $\frac{L_n}{N-1} \geq 1$, the minimum investment by any syndicate participant is one dollar.

total commitment fee).

When we consider the incentive constraint that both the lead and non-leads should have enough value from the relationship with the borrower for them not to walk away from the loan commitment when liquidity shocks hit, we obtain that

$$RL_m + \frac{\delta}{1-\delta}\Pi_L \geq rL_m + m(L_m)L_m, \tag{15}$$

$$R\frac{L_n}{N-1} + \frac{\delta}{1-\delta}\frac{\Pi_{NL}}{N-1} \geq r\frac{L_n}{N-1} + n(\frac{L_n}{N-1})\frac{L_n}{N-1}, \tag{16}$$

where

$$\Pi_L = pL_m(R-r) + C_m - pqm(L_m)L_m - (N-1)x, \tag{17}$$

$$\Pi_{NL} = pL_n(R-r) + C_n - pqn(\frac{L_n}{N-1})L_n. \tag{18}$$

Let $d = \frac{\delta}{1-\delta}$. Then, the programming problem can be written as

$$\min_{R,C,N,L_n} H(p(R-r)L) + G(C); \tag{19}$$

such that

$$(\lambda_m) - (1+pd)L_m(R-r) - d\left[C_m - pqm(L_m)L_m - (N-1)x\right] + m(L_m)L_m \leq 0; \tag{20}$$

$$(\lambda_n) - (1+pd)L_n(R-r) - d\left[C_n - pqn(\frac{L_n}{N-1})L_n\right] + n(\frac{L_n}{N-1})L_n \leq 0; \tag{21}$$

$$(\mu) - R \leq -r;$$

$$(\gamma_m) - C_m \leq 0; \tag{22}$$

$$(\gamma_n) - C_n \leq 0; \tag{23}$$

and we do not impose $L_n \geq 0$ as the first order conditions will ensure this.

The equilibrium allocation between the lead and non-lead (that is provided in the Appendix) is efficient in a risk sharing sense, i.e., $m(L_m) + m'(L_m)L_m = n(\frac{L_n}{N-1}) + n'(\frac{L_n}{N-1})\frac{L_n}{N-1}$; the marginal costs of liquidity provision are equated between the lead and non-leads. The lead obtains a per period profit of $\frac{1-\delta}{\delta}[m(L_m) - (R-r)]L_m$ and the non-lead obtains a per period profit of $\frac{1-\delta}{\delta}[n(\frac{L_n}{N-1}) - (R-r)]\frac{L_n}{N-1}$.

The key comparative static that we focus on is what happens when the non-leads receive an exogenous liquidity cost shock, i.e., $n''_+(L) > n''(L)$ and $n'_+(L) > n'(L)$, the marginal cost of providing liquidity for the non-leads goes up.[19] Thus the non-lead liquidity cost shock becomes more convex. Here, we are designing a new incentive compatible syndicate following the change in non-lead cost of liquidity provision (we are adjusting the syndicates shares and the number of non-leads).

**Proposition 4.** *Suppose $n'_+(L) > n'(L)$ and $n''_+(L) > n''(L)$, for all $L > 0$.*[20] *Then the size of each non lead $\frac{L_n}{N-1}$ must fall, i.e., $(\frac{L_n}{N-1})_+ < \frac{L_n}{N-1}$ which immediately implies that a marginal increase in loan size must lead to larger increase in the number of syndicate members after the liquidity cost shock for non-leads. Also $C^+ > C$, $R^+ = R$, $TC^+ > TC$ and $\frac{C^+}{TC^+} > \frac{C}{TC}$. Further suppose $n(L) = L^\gamma$, $\gamma > 1$, if $\psi L_n > L_m$, then the lead credit line amount increases ($L_m^+ > L_m$) and the lead credit line share $L_m/L$ increases ($\frac{L_m^+}{L} > \frac{L_m}{L}$). Finally, assume that $m(L) = L^\psi, \gamma > \psi > 1$. Then the commitment fee to the lead $C_m$ increases, ($C_m^+ > C_m$).*

Proposition 4 shows that if non-leads have a liquidity cost shock that reduces their ability to credibly provide liquidity in the future, each non-lead will provide a lower credit line size and the lead's credit line size and fractional share must increase. Further, the lead's commitment fee and the total commitment fee must go up.

In the proof of the Proposition 4, we show that an liquidity cost shock increases the number of members of the syndicate only if $\psi L_n > L_m$. Since, generally the lead has less than 50%, this suggests that non-lead syndicate shocks should increase the number of syndicate members.

A related thought experiment that follows from this result is as follows . Suppose

[19] The assumptions that $n_+(0) = n(0) = 0$, $n'_+(0) = n'(0) = 0$ remain true and will not be restated henceforth. At times, we use the cost functions $n_+(L) = L^{\gamma_+}$ and $n(L) = L^\gamma$ where $\gamma_+ > \gamma$. Then we require that $L_m \geq 1$ and $\frac{L_n}{N-1} \geq 1$ to satisfy our conditions, syndicate participants have a minimum participation of one dollar.

[20] $\hat{R} = r$ requires the same condition as Proposition (2) that $\delta \in [\bar{\delta}, 1]$ and hence $\frac{H_R(0)}{G_C(C)} > (\frac{1}{pd} + 1)$. Otherwise, we have $\hat{R} > r$. Conditions II then becomes $\frac{H_R(0)}{G_C(C)} < (\frac{1}{pd} + 1)$ and $\frac{m(L_m)L_m + n(\frac{L_n}{N-1})L_n}{(\hat{R}-r)L} > 1 + \frac{H_R(p(\hat{R}-r)L)}{p(\hat{R}-r)LH_{RR}(p(\hat{R}-r)L)}$. Again, we can show via example that this will hold for a region $[\underline{\delta}, \bar{\delta})$ where $\underline{\delta}$ changes.

the number of syndicate members is fixed for some period of time (until a new syndicate is formed and the credit line is paid off or refinanced). Suppose a liquidity cost shock occurs for the non-leads that is permanent.[21] Then incentive compatibility will determine that how much liquidity is provided and depends depends on the structure of future syndicates, not the current syndicate. The incentive compatibility conditions then becomes:

$$\frac{\delta}{1-\delta}\frac{\Pi^{+}_{NL}}{(N-1)_{+}} \geq m\left((\frac{L_n}{N-1})_c\right) - (R-r)(\frac{L_n}{N-1})_c \tag{24}$$

$$\frac{\delta}{1-\delta}\Pi^{+}_{L} \geq m((L_m)_c) - (R-r)(L_m)_c \tag{25}$$

where the + sign represents the long run future profits and future syndicate sizes while $c$ represents the value of the credit line size that is credible given the new incentive constraint (given the shock to the non-lead liquidity costs) and $(N-1)_c$ is the fixed current number of syndicate members. A simple argument using the incentive constraints above then shows that even under the old credit line contract, only the new credit line sizes are incentive compatible and thus, the overall credit line size must fall though the lead will make up some of the amount of lost due to the shock to the non-leads.[22] We state this result in the following corollary to Proposition 4.

**Corollary to Proposition 4** *Suppose non-lead liquidity provision cost $n(L,\gamma)$ increases in $\gamma$ in that $n'(L,\gamma)$, $n''(L,\gamma)$ increase in $\gamma$ during a given contract (so that the number of banks in the syndicate is fixed). The increase in non-lead liquidity provision cost is a permanent shock. If $\psi L_n > L_m$, then incentive compatibility will decrease the overall loan size in the short run and the lead will take a larger share, partially offsetting the loss of liquidity from non-leads.*

## 2.7 Lead Bank's Other Business with Firm

Another important aspect of syndicates is that the lead often has other business relationships with the borrower. We consider a scenario where lead banks receive an additional

[21] This is a permanent one time change in the liquidity supply costs of the non-lead banks. By Proposition 4, the interest rate $R$ does not change when the costs of liquidity provision of the non-leads changes.

[22] Of course, with a new credit line, the number of syndicate non-leads will readjust.

profit proportional to the size of the credit line they provide. Intuitively, the credit line size will be correlated with the relationship and thus profits will be roughly proportional. We take this as given, recognizing that these aspects themselves could be endogenous.[23]

If a relationship that binds the lead bank to the borrowing firm already exists, then the profits from this relationship can be used to provide the necessary incentive compatibility in liquidity provision. Thus for small loan sizes, no additional profit needs to be provided for incentive compatibility in liquidity provision and the lead provides the credit line; for larger lead loan sizes, the relationship distorts the fraction of the syndicate share that goes to the lead bank.

There is now a tension between risk sharing and efficient liquidity provision and incentive compatibility. In contrast to the analysis in Proposition (4), the allocation is not efficient in a liquidity provision sense: the marginal costs of providing liquidity will not be equated between the lead and non-leads, therefore, there will be a distortion. If $\pi_o L_m$ is the outside profit of the lead bank, then the efficient allocation is distorted to:

$$[m(L_m) + m'(L_m)L_m] = \frac{1}{\frac{1}{d} + pq}\pi_o + \left[n(\frac{L_n}{N-1}) + n'(\frac{L_n}{N-1})\frac{L_n}{N-1}\right]. \tag{26}$$

where the distortion depends on the outside profit parameter $\pi_o$ and parameters $\delta, p, q$. Consequently, the lead will provide a much larger size than is efficient from a liquidity provision perspective.[24]

Specifically, we show that:

**Proposition 5.** *Suppose the lead receives an outside profit proportional to the credit line size, $\pi_o L_m$, then the lead must: (i) for small loan size ($L$) provide the loan on their own ($L \leq \hat{L}$) at zero commitment fee; or (ii) if $L \geq \hat{L}$, then the commitment fees are positive and $N > 1$; compared to the case where there is no outside relationship (Proposition 4) the lead has a larger loan ($L^o_m > L_m$) and a larger loan share. The overall relationship fees and commitment fees paid to the syndicate are higher ($\pi_o L^o_m + C^o_m + C^o_n > C_m + C_n$)*

[23] We take the relationship and the relationship profit contract as exogenous to the credit line decision and given. Thus the firm minimizes the "cost" of providing a credit line to it given its preferences as before, with the relationship profit contract being given.

[24] In Proposition 5 below, we consider the case where the lead has an outside relationship and show that allocations are distorted. The same argument holds for any non-lead who has an outside relationship with the firm, their allocations will be distorted relative to non-leads who do not have an outside relationship with the firm.

*but the direct commitment fees paid to the syndicate must drop, i.e.,* $C_m^o + C_n^o < C_m + C_n$*. Further, we have that overall relationship and commitment fees to the lead are also higher* ($\pi_o L_m^o + C_m^o > C_m$) *and the commitment fees to all non-leads are lower; i.e.* $C_n^o < C_n$*. Finally, the ratio of profits for the lead (including outside relationship) to the non-lead is higher when there is an outside relationship with the lead.*

Thus for small loan size, the lead will provide the credit line on its own. At larger credit line sizes, the size of each non-lead falls and the size and share of the lead increases; further the overall fees and profits to the lead (relationship profits and commitment fees) and overall fees to the syndicate (including relationship profits) go up. However, the direct commitment fees to the syndicate must drop.

**Corollary to Proposition 5** *Suppose non-lead liquidity provision cost* $n(L, \gamma)$ *increases in* $\gamma$ *in that* $n'(L, \gamma)$, $n''(L, \gamma)$ *increase in* $\gamma$*. Then* $0 < \frac{dL_m^o}{d\gamma} < \frac{dL_m}{d\gamma}$*. Hence when non-leads receive liquidity shocks as in Proposition 4, the response of a lead with outside business is much smaller than a lead with no outside business.*

Essentially, the lead bank with outside business has a larger credit line share and thus the marginal cost of providing more credit is higher for such a lead bank, thus the lead with outside business will provide less marginal credit in response to shocks to non-leads. Hence, when a non-lead exits, a lead bank with outside business, surprisingly, will provide less marginal credit since its exposure to the firm is already much higher.

# 3 Data and Sample Characterization

## 3.1 Data

In the second part of our paper, we test some empirical implications of our theory. Our main data sources for this investigation are Dealscan and the Shared National Credit (SNC) program run by the Federal Deposit Insurance Corporation, the Federal Reserve, and the Office of the Comptroller of the Currency.

Dealscan gathers information on syndicated credits at the time of their origination, including the identity of the borrower, the credit type, its purpose, origination amount and date, maturity date, and pricing (credit spread and undrawn fee). We merge Dealscan with Compustat and the Center for Research in Security Prices (CRSP) to get information on borrowers' financials and stock prices, respectively. We also match Dealscan with Reports of Condition and Income to get financial information for the lead bank in the syndicate. Wherever possible we obtain bank data at the holding company level using the Y9C reports. If these reports are not available we rely on Call Reports which have data at the bank level.

Given that Dealscan only reports information (often incomplete) at the time of the credit origination, we also use data from the SNC program.[25] This program tracks, at each year end, confidential information on all syndicated credits – new as well as credits originated in previous years – that exceed $20 million and are held by three or more federally supervised institutions.[26] For each credit, the program reports the identity of the borrower, the credit type, its purpose, origination amount and date, maturity date, bank rating, drawdown amount, and complete information about the syndicate members, including their loan shares.

We merge Dealscan with SNC to investigate the impact of borrowers' historic drawdown rates on the prices they pay on new credit lines. Finally, we complement the SNC data with FDIC data on bank failures to investigate the impact of a syndicate member's failure on the liquidity that credit lines offer their borrowers. We restrict this exercise to bank failures because (with the exception of Bear Stern and Lehman Brothers) we do not have comprehensive information on nonbank failures. This is not a problem because banks are the dominant investors in credit line syndicates. Additionally, we use NBER business cycle expansion and contraction dates to identify the beginning and the end of economic recessions during our sample period.

### 3.2 Sample Characterization

Table 1 reports information on the data we use in our tests. Panel A reports information on credit lines of publicly listed nonfinancial corporations included in Dealscan. The

[25] See Bord and Santos (2012) for a comparison between the SNC and Dealscan databases.

[26] In 2018 the cutoff was raised to $20 to $100 million. The confidential data were processed solely within the Federal Reserve System for the analysis presented in this paper.

data cover 21,120 credit lines from 1988 to 2020 for a total of 32,826 loan-lead bank observations (our unit of analysis when we use Dealscan data).[27]

The average credit line is about $788M, has a maturity of four years, an undrawn fee of 26 bps, an all-in-drawn spread of 155 bps, and a syndicate with 11 participants. Nearly all credit lines are senior, with 36% being secured, 10% having a guarantor, and 39% having a covenant restricting dividends. Most credit lines (74%) are to refinance existing debt. The drawdown rate among the firms that had an outstanding credit line in the year prior to taking out the new credit line was 21%.

In the middle part of Panel A, we see that there is substantial dispersion in the risk of borrowers. The average borrower has a leverage ratio of 31% with the 10th and 90th percentiles equal to 8% and 54%, respectively. The average profit margin is 0.15 and the 10th and 90th percentiles are equal to -0.03 and 0.14, respectively. For stock return (over market return), these figures are 0.002, -0.001 and 0.002. About 38% of the credit lines are from investment-grade rated borrowers, and 21% are from below-grade rated borrowers. The remaining 41% are from unrated borrowers. This dispersion in risk is important because risky borrowers place more value on the liquidity provided by credit lines, The average borrower has a four-year old relationship with the lead bank with the 10th percentile equal to zero. Hence, there is a fair number of borrowers that take out credit lines from banks they have not borrowed from before.

The bottom part of Panel A reports information for the lead banks. The average lead bank has assets worth $998 billion and an equity-to-assets ratio equal to 9%. In line with the assertion that deposit funding gives banks a comparative advantage in granting credit lines, we see that the average lead bank has a deposit-to-asset ratio equal to 56% and the 10th percentile of the deposit distribution is equal to 39%.

Panel B of Table 1 reports statistics for our sample of credit lines in the SNC program. The data cover 44,233 credit lines from 1988 to 2020 for a total of 1.4M loan-bank-year observations. There are a total of 23,573 distinct corporate borrowers represented in our data. Given that our unit of observation when we use the SNC data is loan-bank-year we do not restrict the sample to publicly listed borrowers in this part of

[27]About 41% of the sample credit lines have one lead arranger with the remaining having two or more lead banks.

our analysis. There are a total of 19,025 unique lenders of which 706 act as lead banks.

The average drawdown rate is 37%, with the 10th and 90th percentiles being 0% and 100%, respectively. The average credit line is $223 million and has three years left before it reaches its maturity date. About 89% of the credit lines are rated PASS by the lead bank.[28] On average, syndicate members own 11% of the credit line, but the 10th and 90th percentiles are 2% and 25%, respectively. On average, the lead bank owns 25% of the credit line with the 10th and 90th percentiles at 0% and 50%, respectively. There is also significant variation in the size of syndicates. The average syndicate has 9 banks, but the 10th and 90th percentiles have 3 and 18 banks, respectively. Finally, about 73% of the members in credit line syndicates have a lending relationship with the borrower

# 4 Supporting Evidence for our Model's Predictions

We test implications of our theory, fpcusing on implications that are unique to our theory and that our data can shed light on. We begin by testing the predictions on syndicates. Next, we investigate the predictions on the lead bank's role on the liquidity offered to borrowers. Finally, we test our model's predictions on the pricing of credit lines.

## 4.1 Credit Line Syndicates

### 4.1.1 Size of Credit Line Syndicates

Our theory has two predictions about the size of credit line syndicates. Proposition 2 posits that larger credit lines have larger syndicates. The intuition here is that with larger credit lines, risk sharing requires the entry of new syndicate members, even though it is costly. Proposition 4 argues that the link between credit line size and syndicate size is stronger for credit lines taken out in recessions. With an increase in the marginal cost of liquidity provision, the relationship between size of credit lines and number of members is accentuated.

Figure 2 shows that there is a distinct positive correlation between the size of the

[28] Banks rate loans (including portions of the loan) into five categories: PASS, SPECIAL MENTION, SUB STANDARD, DOUBTFUL and LOSS, with PASS being the highest category.

syndicate and the size of the credit line both in the recessions and in good times. It also shows that this effect is more pronounced for credit lines taken out during recessions. A one-percent increase in the size of credit lines taken out during recessions translates into a 0.37 percent increase in the number of participants in the syndicate. For credit lines taken out in good times that elasticity is only 0.35. Of course these fitted values do not account for many other factors that likely explain the size of syndicates. To account for these and investigate the claim in Proposition 2, we estimate the following model:

$$\begin{aligned} LLENDERS_{c,f,b,t} = \alpha_0 + \alpha_l LAMOUNT_{c,f,b,t} + \beta_1 LOAN_{c,t} + \\ \beta_2 BORROWER_{f,t-1} + \beta_3 BANK_{b,t-1} + T_t + \epsilon_{c,f,b,t} \end{aligned} \tag{27}$$

where $LLENDERS_{c,f,b,t}$ is the log of the number of syndicate investors at origination in credit line $c$ from firm $f$ taken out from lead bank $b$ at time $t$. Our key variable of interest is $LAMOUNT$, the log of the credit line amount. We investigate the relationship between these variables controlling for sets of borrower-, loan-, and bank-specific factors as well as time (year-quarter) fixed effects.

Our loan controls account for the maturity of the loan, and include dummy variables to account for different covenants and other lender-protection arrangements as well as dummy variables to control for the purpose of the credit line. Our borrower controls account for the size of the borrower, its profitability, growth opportunities, and default risk both as captured by accounting variables, the credit rating, and stock market information. Additionally, we control for the borrower's sector of activity and for the strength of its relationship with the lead bank. Our bank controls account for the size, profitability, liquidity and financial condition of the lead bank(s) in the syndicate. See Appendix A for the definitions of all the variables and their data sources.

The results of this investigation are reported in Columns (1)-(3) of Table 2. Column 1 reports the results of a pooled analysis while Column 2 adds borrower fixed effects. Column 3, in turn, uses bank-borrower fixed effects. Across the three models, we see that $LAMOUNT$ is positive and highly significant. A one-percent increase in credit line size is associated with an increase in the number of investors that varies between 0.25% (Column 1) to 0.16% (Column 3). These findings, in particular that of Column

(3) which is estimated with bank-borrower fixed effects, provide important support to Proposition 2 insight that larger credit lines should have larger syndicates in order to increase their liquidity insurance capacity.

Next, we turn our attention to Proposition's 4 claim that the link between syndicate size and credit line size should be stronger in recessions. Towards that end, we augment model (27) to include our recession dummy variable, $RECESSION$, and its interaction with the log size of the credit line. The results of this investigation are reported in Columns (4)-(6) of Table 2, which adopt the same set of fixed effects as Columns (1)-(3). Across the three models $LAMOUNT$ and $RECESSION \times LAMOUNT$ are positive and highly significant. Our control for the recessions, $RECESSION$, drops out because of the time fixed effects include in the models. A one percent increase in the size of credit lines taken out during recessions is associated with an additional increase in the number of syndicate investors which ranges from 0.10 (Column 4) to 0.05 (Column 6) when compared to credit lines taken out in good times. Therefore, consistent with the conjecture of Proposition 4, the size of the credit line plays a more important role on the size of the syndicate for credit lines taken out during recessions.

#### 4.1.2 Syndicate Members' Investments

Next, we focus on the insights of our theory on syndicate members' investments. According to Proposition 5, banks with a relationship with the borrower (and hence outside profits) will make larger investments in the credit line and are less likely reduce their investments and leave the syndicate during the life of the credit line. As already argued, outside business with the borrower relaxes the incentive constraint for the lead bank and thus induces the lead to provide a larger loan to the borrower (Proposition 5). These insights carry over when we consider non-leads who have relationships.

We capitalize on the SNC program's unique data on loan shares for *all* investors during the life of the credit line to test these predictions. Figure 3 takes a first look at the two assertions of Proposition 5. The left figure relates the loan share at the time of the credit line origination with the length of the bank-borrower relationship. Its fitted line estimated with credit fixed effects shows that within each credit line banks with longer relationships with the borrower make large investments. The right figure, in turn, looks at the age of the bank-borrower relationship for banks that exit the credit line syndicate vs. those that remain in the syndicate throughout the life of the credit line. Banks that exit credit line syndicates have on average shorter lending relationships with borrowers when compared to those that remain funding the credit line.

To investigate this relationship formally, we consider the following model:

$$\begin{aligned} SHARE_{c,f,b,t} = \alpha_0 + \alpha_l RELAT_{b,f,t-1} + \beta_0 LEAD_{c,f,b,t} + \\ C_c \times T_t + B_b + \epsilon_{c,f,b,t} \end{aligned} \tag{28}$$

where $SHARE_{c,f,b,t}$ is the share of credit line $c$ of firm $f$ held by bank $b$ at date $t$. We consider two approaches to measure the relationship the bank has with the borrower. The first builds on the age of their lending relationship. In this case, $RELAT$ is either a dummy variable, $RELAT_{Aged}$, equal to 1 if the bank has a lending relationship with the borrower (i.e. it has funded a *prior* credit line (or term loan) of that borrower during our sample period), or the number of years since the bank first funded a credit line (or term loan) of that borrower during our sample period, $RELAT_{Agey}$.

The second approach builds on the depth of their relationship as captured by the bank's investment in the borrower term loans. Under this approach, $RELAT$ is either a dummy variable, $RELAT_{TLd}$, equal to 1 if the bank has an investment in one the of the borrower's outstanding term loans (in addition to investing in its credit line) or the share of the borrower's term loans that the bank owns, $RELAT_{TLsh}$. We also consider the importance of the bank's investment in the borrower's term loans but this time measured relative to all of the bank's outstanding term loan investments, $RELAT_{BKTLsh}$.

$LEAD$ is a dummy variable for the lead bank of the credit line. We do not include additional variables in model (28) because we capitalize on the panel structure of our data on syndicate-members' investments and estimate model 28 with credit-year and bank-year fixed effects. In other words, we are comparing within each syndicate-year banks' investment decisions depending on their relationship with the borrower while still accounting for the bank's overall investment decisions in that year.

The results of this investigation are reported in Table 3. The top panel reports results when we limit the sample to the origination year of the credit line. The bottom panel, in turn, reports results when we consider information on *all* of the years for which the credit is alive. In both panels, the first two columns report results when we focus on the age of the bank-borrower relationship while the last three columns report results when we consider the depth of their relationship.

It is apparent from Panel A that banks make larger investments in credit lines at origination when they have a relationship with the borrower. Banks' loan shares in credit lines of borrowers to whom they have lent before are 1.1 percentage points higher when compared to loan shares of banks with no prior lending relationship (Column 1). Similarly, banks' credit line shares are 1.0 percentage points higher when banks also invest in the borrower's term loans when compared to banks that only invest in the borrower's credit line (Column 3). For reference, the mean bank share in the year of the credit line origination is 10.4%.

We also see from Panel A that banks' investments in credit lines at origination increase with the strength of their relationship with borrowers. The credit line share of a bank with a five-year lending relationship is 40 bps higher when compared to that of a bank that invests in the same credit line but only has a one-year relationship (Column 2). Similarly, a one-standard deviation difference in banks' term loan shares of a borrower (0.05) is associated with a 2.2 percentage points difference in the credit-line shares of those banks when they invest in the same credit line of that borrower (Column 4). Column (5) shows this insight is also present if we, instead, measure the importance of term loan investments relative to the bank's portfolio of term loans.

Looking at Panel B of Table 3 we see that the insights derived from banks' investments at the time of the credit line origination continue to hold when we factor in information over the life of credit lines. These findings are in line with the second prediction of Proposition 5 that banks with a relationship with the borrower are less likely reduce their investments and leave the syndicate during the life of the credit line. We investigate this prediction more directly next using a modified version of model (28) where the dependent variable is a dummy variable which takes the value one at year $t$ for banks who were in the syndicate in year $t-1$ but are not present anymore in year $t$.

In this case, we control for the investor's relationship with the borrower as of year $t-1$, i.e. the last year before it decided to exit the syndicate. As we did above, we estimate our results using credit-year and bank-year fixed effects.

The results of this exercise are reported in Table 4. Banks that have a relationship with a borrower are less likely to exit the borrower's credit line syndicate. Banks that have granted funding to borrowers in the past are 90 bps less likely to exit each year the credit line syndicates of those borrowers when compared to banks with no lending relationship (Column 1).[29] Similarly, banks that also fund borrowers' term loans are 40 bps less likely to exit each year credit line syndicates of those borrowers when compared to banks that only fund their credit lines (Column 3). Further, our results show that the stronger the relationship the less likely it is for the bank to exit the borrower's credit line syndicate. This is true whether we measure the strength of the relationship by the number of years the bank has been granting funding to the borrower (Column 2) or the size of the bank's investment in the borrower's term loans (Columns 4 and 5).

In a nutshell, our findings, which are very tightly estimated because they include in addition to credit-year fixed effects, bank-year fixed effects, are consistent with Proposition 5 insights. Banks with a relationship with the borrower either by virtue of granting it funding in the past or by virtue of having other businesses with it (e.g. funding term loans), make larger investments in the borrower's credit lines and are less likely to exit the borrower's credit line syndicate for the duration of the credit line. Further the older the relationship or the larger the term loan investment the bigger is the bank's investment in borrowers' credit lines and the less likely are them to exit the syndicate.

### 4.2 Lead Banks and Credit Lines' Liquidity Insurance

Our next test relates to the role of the lead bank in preserving the liquidity insurance function of credit lines.

Perhaps the biggest risk to credit lines' liquidity insurance is the risk of failure of a syndicate member because it will result in a reduction of the credit line, unless other

[29] Note that if exit occurs in year $t$, we measure the relationship in year $t-1$ and our relationship dummy will indicate whether the bank has lent to that borrower in the past i.e. $t-2$ or before.

banks step in and take on the investment of the failed bank. In this regard, the lead bank plays a key role because it arranged the credit line and it tends to have a large loan share.[30] In the Corollary to Proposition 4, we show that if locally (until a new credit line is originated) the number of syndicate members is fixed, then a liquidity shock that results in non-leads reducing their liquidity provision will also result in the lead bank increasing its liquidity provision partially; hence there will be a drop in the credit line's total liquidity provision.[31]

We test this empirical implication using the failure of 135 non-lead banks in our credit-line syndicates; these banks were present in 634 credit lines at the time of their failure.[32] Figure 4 plots the time series of those bank failures (left graph), and the number of credit lines in which they were present in the year they failed (right graph). As one would expect, bank failures cluster around recessions, in particular the recession of 1998/99 and that of 2008/09.

Figure 5, left graph, plots the log of one plus the lead bank increase in the credit line commitment in the year of failure against the log amount held by the failing bank(s) prior to their failure. As we can see from the fitted line, lead banks do increase their loan investments but not in a way that is positively correlated with the size of failed banks' loan investments. This is consistent with lead banks providing some protection but without fully insuring borrowers against the risk of failure in credit line syndicates.

The right graph of 5 corroborates that assertion. This figure plots the log of one plus the reduction in the amount of the credit line commitment in the year of failure against the log of the credit line investment by failed banks. Looking at the fitted lines, we see that credit lines experience lower reductions at the time of a syndicate member failure when the lead bank increases its loan investment. Further, even when the lead bank increases its loan investment the credit line still experiences a reduction. Thus, lead banks do not appear to fully insure borrowers of credit-lines against the risk of the failure of syndicate members.

[30]For 97% of the credit-year observations in our sample, the lead bank has the largest loan share.

[31]We view the failure of a non-lead bank as a shock that increases the cost of non-leads supplying liquidity under stress.

[32]We restrict this exercise to bank failures (including Bear Stern and Lehman Brothers) because we do not have a comprehensive database on nonbank failures. However, as noted above credit line syndicates are dominated by banks.

We take a closer look at lead banks' investment decisions using regression analyses. We start by investigating lead banks' responses to syndicate member failures. Given that we have information on *all* syndicate members we focus our analysis on within credit-year identification. That is, we investigate the lead bank's response relative to that of the other non-failed syndicate members within the credit-year of failure. We consider the following model:

$$\begin{aligned}\Delta INVEST_{c,f,b,t} = \alpha_0 + \alpha_1 FAIL_c + \alpha_2 FAILY_t + \alpha_3 LEAD_{c,f,t} + \\ \alpha_4 LEAD_{c,f,t} \times FAIL_c + \alpha_5 LEAD_{c,f,t} \times FAILY_t + \\ \beta_0 LINVEST_{c,f,b,t-1} + \beta_1 RELAT_{c,f,b,t-1} + Cc \times T_t + B_b + \epsilon_{c,f,b,t},\end{aligned} \tag{29}$$

where $\Delta INVEST_{c,f,b,t}$ is either a dummy variable, $INVESTu$, equal to one for syndicate members that increase their investment in the credit line over the year, or the log of the additional investment the member makes over the year, $L\Delta INVEST$. $FAIL_c$ is a dummy variable for credit lines that experience a syndicate member failure over their life while $FAILY_t$ is dummy variable for the year that credit line experiences the failure. $LEAD$ is a dummy variable for the lead bank in the syndicate. $LINVEST$ and $RELAT$ is the log of the bank's loan investment and the number of years since the bank first lent to the borrower (both lagged), respectively. We do not include additional loan and borrower controls because we focus on estimates with credit-year fixed effects. We do not include additional participant bank controls because we do not have bank-level data for many of the banks and some nonbanks that fund credit lines. Nonetheless, we consider specifications where we include bank or bank-year fixed effects.

The key variable of interest in model (29) is $LEAD \times FAILY$ because it tells us how the lead bank responds relative to the other syndicate members in the year the syndicate experiences the failure of a member. Table 5 reports the results of our investigation. Panel A reports results when we estimate model (29) with the dependent variable indicating whether the participant bank increased its loan investment over the year. Panel B, in turn, reports the results when we estimate that model with the dependent variable equal to the log of the additional loan investment made by the participant bank over the year. In both panels, Column (1) is estimated with credit fixed effects while Column (2) is estimated with credit-year fixed effects. In column (3), we include in addition to credit-year, bank fixed effects. Of course one may still worry about potentially important time-varying differences among participants. For that reason, in Column (4) we include both credit-year and participant-year fixed effects.

Looking at Panel A we see that $LEAD \times FAILY$ is positive and statistically significant across the four columns. The coefficient varies between 0.04 and 0.07, thereby indicating that in years where syndicates experience the failure of a member, lead banks are about 6% more likely to increase their investment in affected credit lines when compared to the remaining participant banks. Panel B portrays a similar message. Again we see that $LEAD \times FAILY$ is positive and statistically significant across the four columns, *albeit* with a slightly smaller coefficient. This was expected given that the dependent variable in that panel is the log of the additional investment rather than a dummy variable for when a participant bank increases its investment in the credit line.

One final observation about the results reported in Table 5. We see that across both panels the coefficient on $RELAT_{Agey}$ is negative and statistically significant, indicating that syndicate members with longer-term lending relationships with borrowers are less likely to increase their loan shares (or make smaller increases) during the life of the credit line. While this finding may appear counter intuitive (e.g. Table 4 shows that stronger relationship reduce the likelihood of exiting the syndicate) it is in fact consistent with Proposition 5 Corollary, which argues that leads with outside business will increase their investments less. This result, which extends to non-leads, arises because banks with outside business are already overexposed to the credit line and thus find it more costly to expand credit. Recall that our evidence from Table 3 shows that banks with stronger relationships make larger investments at the time of the credit line origination.

The results of our regression analysis confirm the insights from Figure 5: lead banks are indeed more likely to respond and make larger additional investments in credit lines following the failure of a syndicate member. These results clearly show that lead banks offer borrowers some insurance against the risk of failure of syndicate members in the credit lines they arranged. The small magnitude of our estimates suggests, consistent with the prediction of our Proposition 4, that lead banks offer only partial insurance.

We take a closer look at this assertion next using the following model:

$$\begin{aligned}
&CUT_{c,f,b,t} = \alpha_0 + \alpha_1 FAIL_c + \alpha_2 FAILY_t + \alpha_3 L\Delta LEADINVEST_{c,f,t} + \\
&\alpha_4 L\Delta LEADINVEST_{c,f,t} \times FAIL_c + \alpha_5 L\Delta LEADINVEST_{c,f,t} \times FAILY_t + \\
&\beta_1 LOAN_{c,t-1} + \beta_2 BORROWER_{f,t-1} + \beta_3 BANK_{b,t-1} + C_c \times B_b + \epsilon_{c,f,b,t},
\end{aligned} \tag{30}$$

where $CUT_{c,f,b,t}$ is either a dummy variable when the credit line experiences a reduction between year $t-1$ and year $t$, or the log of one plus the size of that cut. $L\Delta LEADINVEST_{c,f,t}$ is the log of one plus the additional investment the lead bank makes between years $t-1$ and $t$. $FAIL_c$ and $FAILY_t$ are dummy variables as defined in model (29) Finally, $LOAN$, $BORROWER$, and $BANK$ are our sets of loan-, borrower and lead bank-specific factors as specified in model 27.[33]

The key variables in model (30) are $FAILY$ and $L\Delta LEADINVEST \times FAILY$, and more specifically their sum. Consider the case when the dependent variable is a dummy variable indicating the credit line experienced a reduction over the year. Here, that sum will tell us whether the likelihood of a reduction when the lead bank increases its loan investment is different in the year of a syndicate member failure from the years when there are no member failures. If the lead takes on the role of fully hedging the borrower against the risk of syndicate member failures then we would expect that sum to be equal to zero. A similar interpretation applies to that sum when we estimate model (30) with the dependent variable equal to the log of the reduction

The results of this exercise are reported in Table 6. Panel A reports results for the likelihood of a reduction in the size of the credit line while Panel B reports results for the size of the credit line annual reduction. In both panels, Column (1) includes credit fixed effects while Column (2) is estimated with lead-bank fixed effects. Column (3) is estimated with lead bank-credit fixed effects. Finally, we report at the bottom of each column the p value for the null hypothesis that $FAILY + L\Delta LEADINVEST \times FAILY = 0$.

[33]We do not include in this analysis the subset of accounting and stock price borrower-specific controls that we consider in our study of credit lines' syndicates (Section (4.1.1) because these limit our sample to publicly listed firms and are arguably less important for lead banks' investment decisions following the failure of a syndicate member.

Looking at Table 6, we see the results are similar in both panels and across the three specifications in each panel, confirming their robustness. The lead bank plays an important role in reducing the likelihood (and the size) of a credit line cut at the time of a syndicate member bank failure, but this additional effect is not enough to fully hedge the borrower from that failure. For example, looking at Column (3) of Panel B and focusing on credit lines that experience a syndicate member failure at some point during their life, we see that a 1% increase in the lead bank investment is associated with a 12% reduction in the size of the cut that these credit lines experience in non-failure years ($L\Delta LEADINVEST + L\Delta LEADINVEST \times FAIL$. In the years of syndicate-member failures, a 1% increase in the lead bank investment is associated with an additional 10% reduction in the size of cut. This additional effect, however, is not enough to eliminate the negative effect of the failing bank because the sum of $FAILY$ and $L\Delta LEADINVEST \times FAILY$ is positive and statistically different from zero.

In sum, the failure of a syndicate member bank increases both the odds borrowers will experience a reduction in their credit lines and face larger reductions on their credit lines. Lead banks often (but not always) respond by increasing their investments in credit lines, thereby reducing the adverse effect of the failure of syndicate member banks. This is consistent with Proposition 4 that suggests that lead banks will partially offset the decline in credit line liquidity triggered by non-leads' reduction in loan investments.

## 4.3 Pricing of Credit Lines

Finally, we test the three predictions of our model on credit lines' pricing.

### 4.3.1 Pricing of Credit lines and Borrowers' Liquidity Needs

We begin by investigating Proposition 3 results that banks charge higher commitment fees and lower spreads on credit lines to borrowers with higher probabilities of drawdowns i.e. borrowers which are expected to utilize their credit lines more extensively. A higher probability of drawdown is clearly more costly for the syndicate, hence overall cost of the credit line has to go up. However, a higher probability of a drawdown makes the borrower care more about insurance, i.e., the borrower does not want the interest rate to be high since the probability of drawdown is higher. This results in the commitment fee being higher and the interest rate being lower. Since syndicates learn about drawdown probabilities from prior histories, higher prior drawdown rates are a good instrument for higher future probabilities of drawdown. OF course, higher prior drawdowns could suggest higher future credit risk, which we would need adequately control for.

We rely on Dealscan to get information on credit lines' fees and spreads. Specifically, we use the all-in-undrawn fee, which reflect both the commitment fee and other fees borrowers pay when they take out credit lines. The commitment fee compensates banks for the liquidity risk they incur by guaranteeing the firm access to funding at its discretion over the life of the credit line and up to the total commitment amount. The other fees, which can be annual or paid only at the time of origination, are to compensate the services of lead bank in the syndicate, among other things. We rely on Dealscan's all-in-drawn spread, which is defined over Libor, to proxy for the spread in our model. The all-in-drawn spread, which equals the annual cost to a borrower for drawn funds, accounts for the credit spread but it also reflects fees borrowers pay when they draw down their credit lines.[34] We use the SNC program to get information on borrowers' drawdown rates on their past credit lines, our proxy for their liquidity needs.

Figure 6 plots the undrawn fees (left figure) and all-in-drawn spreads (right figure) on new credit lines against their borrowers' lagged drawdown rates. Clearly, firms that drew down more in the past pay higher undrawn fees and all-in-drawn spreads on their new credit lines. While at a 10% past drawdown rate, the undrawn fee on new credit lines is around 27 basis points, at the a 90% past drawdown rate the undrawn fee is around 40 basis points, a 48% increase. All-in-drawn spreads, in turn, range from around 165 to 240 basis points, or a 45% increase as past drawdown rates rise from 10% to 90%. To the extent that past drawdowns predict a higher probability of future drawdowns the evidence on undrawn fees is consistent with Proposition 3. However, the evidence on all-in-drawn spreads is not in line with Proposition 3. This could be because past drawdown rates signal not only higher future liquidity needs but also higher credit risk.

[34]Dealscan reports separate information on credit spreads but only for less than 3% of credit lines. However, for these credit lines, credit spreads represent 58% of their all-in-drawn spreads.

To disentangle these effects, we consider the following model of credit lines' prices:

$$PRICE_{c,f,b,t} = \alpha_0 + \alpha_l DRAWDOWN_f + \beta_2 BORROWER_{f,t-1} + \\ \beta_1 LOAN_{c,t} + \beta_3 BANK_{b,t-1} + \beta_4 MKT_t + C_c \times B_b + T_t + \epsilon_{c,f,b,t} \tag{31}$$

where $PRICE_{c,f,b,t}$ is either the undrawn fee or the all-in-drawn spread on the credit line $c$ from borrower $f$ taken out from bank $b$ at date $t$. $DRAWDOWN_f$ is the expected drawdown rate on that credit line which we proxy by the average drawdown rate on the credit line the borrower had outstanding in the three years before it took out the new credit line. We control for the sets of loan-, borrower- and lead bank-specific factors, $LOAN$, $BORROWER$, and $BANK$, respectively, that we used in Section (4.1.1) when we investigate the size of syndicates. Additionally, we control for the market conditions at the time of the credit line origination, $MKT$, by including the three-month Libor and the spread between triple-B and triple-A corporate bonds. Finally, we complement these controls with year-quarter fixed effects, $T$. See Appendix A for the definitions of all the variables and their data sources.

Table 7 shows the results of our investigation of model (31). Columns (1)-(3) report results for the undrawn fee while Columns (4)-(6) report results for the all-in-drawn spread. Finally, Columns (7)-(9) report results for the ratio between the undrawn fee and the all-in-drawn spread for the same credit line. In each panel, the first column show the results of a pooled analysis, the second column account for borrower fixed effects, and the third column show the results when we account for lead bank-borrower fixed effects. The latter are arguably the best identified results because they compare the undrawn fees and all-in-drawn spreads (as well as their ratio) on credit lines by the same bank to the same borrower.

Borrowers with higher past drawdown rates pay higher undrawn fees on their new credit lines. Note that $DRAWDOWN$ is significant at 1% even with bank-borrower fixed effects (Column 3). According to that model, a one percent increase in the past drawdown rate leads to a 4.5 bps increase in undrawn fees or 18.8% of the sample mean (24 bps) on new credit lines. This is consistent with the insight from Proposition 3 that borrowers with a higher probability of drawdown pay higher fees on their credit lines.

Borrowers with higher historic drawdowns also pay higher all-in-drawn spreads on their new credit lines. According to Column (6), which depicts results estimated with bank-borrower fixed effects, a one percent increase in the past drawdown rate leads to a 27.7 basis point increase in all-in-drawn spreads or 17.6% of the sample mean (155 bps) on new credit lines. This finding, in contrast to our result on undrawn fees, runs counter the insights of Proposition 3 which posits that banks will charge lower spreads on credit lines to borrowers with higher liquidity needs. It is possible that the past drawdown rate reflects some credit risk which is not captured by our sets of loan and borrower controls. It is also possible that our finding derives from the fees' component of the all-in-drawn spread. Regardless, it is reassuring to see that undrawn fees seem more sensitive to past drawdowns than all-in-drawn spreads. This is apparent in our marginal estimates from Columns (3) and (6). It is also apparent in Columns (7)-(9) which show the results for the ratio between the undrawn fee and the all-in-drawn spread on the same credit line although the coefficient on $DRAWDOWN$ is never statistically significant.

In sum, our evidence supports Proposition 3 result that borrowers with higher liquidity needs should pay higher commitment fees on their credit lines. By contrast, our finding on all-in-drawn spreads is not in line with Proposition 3 insight that borrowers with higher liquidity needs should pay lower spreads on their credit lines. Nonetheless, it is reassuring to see that undrawn fees are relatively more sensitive to drawdown rates than all-in-drawn spreads, which is broadly consistent with Proposition 3 insight that the cost of borrowers' liquidity needs should be captured in credit lines' commitment fees rather than their spreads.

#### 4.3.2 Pricing of Credit Lines over the Business Cycle

Next, we investigate Proposition 4 result that the commitment fee that banks charge to grant liquidity through credit lines increases in response to supply shocks akin to those we observe in recessions. Given that borrowers' liquidity needs and the risk of failure tend to increase in downturns we would expect both commitment fees and credit spreads to increase in recessions. However, once we account for the drivers of liquidity risk and credit risk as well as banks' costs of hedging these risks, our model suggests that supply shocks that happen in recessions should have an bigger impact on commitment fees rather than on credit spreads.

Figure (7) plots the annual average of undrawn fees (left figure) and all-in-drawn spreads (right figure) on new credit lines. A casual look at Figure (7) shows that both undrawn fees and credit spreads tend to go up during recessions. This is particularly evident in the 2008/09 recession.

In the Internet Appendix, we confirm these insights using a pricing model of credit lines. Our results show that undrawn fees of credit lines taken out during recessions are on average 2 to 3 bps higher (about 12% of the sample mean (26 bps)). For all-in-drawn spreads, our results show they are on average 6 to 7 bps higher (about 5% of the sample mean (155 bps)). Consistent with our theory, these results suggest the increase is relatively larger in undrawn fees. This is also apparent during the 2008/09 recession where undrawn fees went up by 6 bps (21% of the mean) while all-in-drawn spreads increased by 15 to 25 bps (10 to 16% of the mean). We investigate next this hypothesis formally using the following pricing model:

$$\frac{Undrawn\,fee}{All-in-drawn\;spread}_{c,f,b,t} = \alpha_0 + \alpha_l RECESSION_t + \beta_1 LOAN_{c,t} + \tag{32}$$
$$\beta_2 BORROWER_{f,t-1} + \beta_3 BANK_{b,t-1} + C_c \times B_b + \epsilon_{c,f,b,t}$$

where the dependent variable is the ratio between the undrawn fee and the the all-in-drawn spread on credit line $c$ of firm $f$ from bank $b$ at issue date $t$. The key variable of interest in that specification is $RECESSION$, a dummy variable equal to 1 for if the credit line was taken out during one of the three NBER recessions during our sample period (1990/91, 2001, and 2008/09).[35] We investigate the impact of recessions on banks' pricing of credit lines controlling for the same set of borrower-, loan- and lead bank-specific factors we use in the previous subsection.

The results of this investigation are reported in Table 8.[36] Column (1) reports

[35]Given we have information on the origination date of each credit date, we use information from NBER's peak and trough dates to identify the beginning and the end of each recession.

[36]The sample used in this analysis is larger than the sample used in the investigation of the impact of drawdowns because

results from pooled analysis; Column (2) report results estimated with borrower fixed effects; and Column (3) report results estimated with bank-borrower fixed effects. Even though both undrawn fees and all-in-drawn spreads go up in recessions, consistent with our theory the former increase by more. Across the three models we see that the undrawn fee-spread ratio goes up in recessions by 1 bp (about 5% of the sample mean).

In total, consistent with Proposition 4, our results show that during recessions there is an increase in the cost of credit lines as captured by their fees and credit spreads. Further, and more specific to our theory, fees increase by more than credit spreads in recessions. The fact these effects persist when we account for bank-borrower fixed effects, i.e. by comparing the pricing of credit lines from banks to the same borrowers in and out of recessions, adds important support to our theory.

#### 4.3.3 Pricing of Credit lines and Bank-Borrower Relationships

Our last test relates to Proposition 5 result that lead banks offer discounts on credit lines to borrowers with whom they have relationships. Relationships create long run profits which relax the incentive compatibility constraints of the lead relative to the non-lead, inducing the lead to take a higher share of the credit line and lower commitment fees (since some rents are obtained outside the credit line itself). Proposition 5 shows that these deviations from the case when the lead bank does not have a lending relationship occur mainly through the undrawn fee rather than the all-in-drawn spread.

To investigate this hypothesis we reestimate model (95) where the dependent variable is the ratio between the undrawn fee and the all-in-drawn spread on the credit line.[37] Given our focus on the importance of the borrower-bank relationship as opposed to the impact of recessions, we also control for market conditions by including the Libor 3 month and the triple-B over triple-A spread in the bond market at the time of the credit line origination.

We consider two alternative measures of bank-borrower relationship. The first measure, $RELAT_{Agey}$, captures the number of years between the current credit line and

here we do not need to merge Dealscan with SNC to gather information on borrowers' historic drawdown experiences.

[37]This allows us to account for any unobservable credit-line factors that may affect its pricing and, therefore, better identify whether borrowers benefit from a discount when they maintain a relationship with the lead bank.

the year the borrower first took out a loan from the lead bank during the sample period (1987-2020). If the borrower continues to take out loans from that lead bank over time this relationship variable will reflect the strength of their relationship; if not then our variable will be noisy. To address this concern, we created a new relationship variable, ($RELAT_{Number}$), which captures the number of credit lines the borrower has taken out from the lead bank during the sample period. We code that variable so that it takes the value 1 on the second credit line the borrower took from the lead bank, the value 2 on the third credit line and so forth.

The results of this investigation are reported in Table 9. Columns (1)-(3) report results for the relationship variable $RELAT_{Agey}$ while Columns (4)-(6) report results for the relationship variable $RELAT_{Number}$. Across the six models we see that our relationship variables are negative and highly statistically significant. Thus, as the age of the relationship between the bank and the borrower increases or as the number of loans the borrower takes out from the lead bank increases the borrower benefits from a reduction in the undrawn fee (relative to the credit spread) charged on its credit lines.

To deepen our understanding on how the discount evolves as the relationship ages, we reestimated Columns (3) and (6) with dummy variables to capture each year in the bank-borrower relationship. The coefficients for the dummy variables capturing the first ten years of the relationship are plotted in the two panels of Figure (8), respectively.[38] Both measures of relationship show a similar picture: borrowing repeatedly from the *same* lead bank affords the borrower a discount in the undrawn fee (relative to the credit spread) on the credit line which increases with the depth of the relationship with the bank, thereby, adding support to our Proposition 5.

# 5 Conclusion

In this paper, we provide a model of credit line syndicates with a trade-off between insurance considerations (sharing of liquidity shocks) and incentive considerations (limited commitment to provide liquidity insurance). According to our model, lead banks has a

[38]In both regressions, the omitted dummy variable is the first loan the borrower takes out from the lead bank during the sample period.

special role for two reasons – better liquidity provision and stronger *ex post* incentives to provide liquidity. Our model yields predictions about the lead and non-lead shares, lead and non-lead commitment fees and credit spreads. Our model also yields comparative statics as to how syndicates change when the cost of liquidity provision goes up or when syndicates experience shocks akin to the failure of a syndicate member.

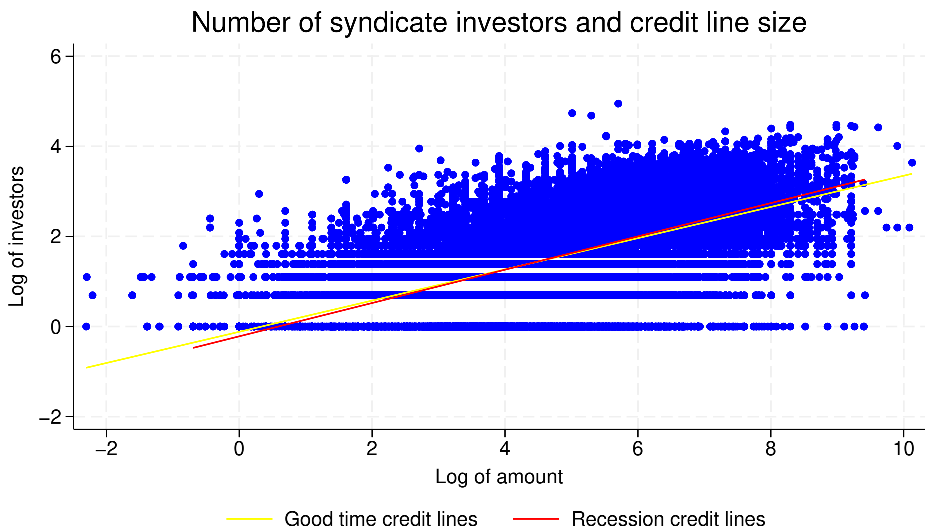
We unveil empirical evidence consistent with our model. First, syndicate size increases in credit line size and this relationship is steeper in recessions. Second, we show that fees and spreads increase in recessions, consistent with the idea that liquidity provision is more difficult in such periods. Further, the ratio of fees to spreads robustly increases in recessions, consistent with the model implication that fees increase more than spreads when the cost of liquidity provision goes up. Thirdly, we find that banks with outside relationships with the borrower do have higher credit line shares and are less likely to exit the credit line. Finally, we uncover evidence in support of the lead bank's unique role. Specifically, we show that lead banks are more likely to increase their investments than non-lead banks following the failure of a member bank but they do not fully offset the credit line size lost due to the failed bank. Taken together, our empirical results provide robust evidence in favor of our model.

Overall, our results are supportive of the insight first expressed in Holmstrom and Tirole (1997) and Rampini and Viswanathan (2019b) that the credibility of credit line commitments is critical for their liquidity provision role. In our model, this credibility comes from the continuing relationship between the syndicate and the firm, including other business relationships that the firm has with syndicate members. Our model suggests a tension between the insurance aspect of syndicate construction and the incentive aspect of syndicate construction and we show that this is present in the data.

**Figure 1: Credit line drawdowns during Covid-19 outbreak**

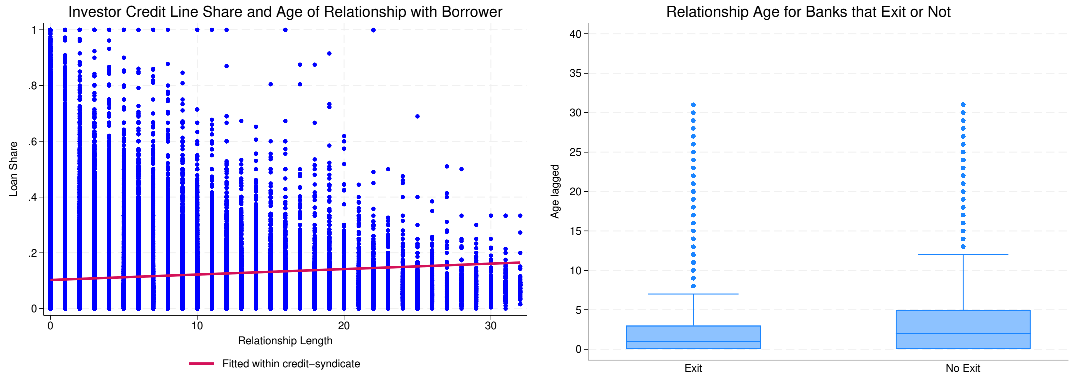

This figure plots drawdowns rates between March 12 and April 9, 2020 for corporations that experienced a credit rating downgrade or were put on a watch list by S&P or Moody's' Source: LCD

**Figure 2: Number of investors and credit line size**



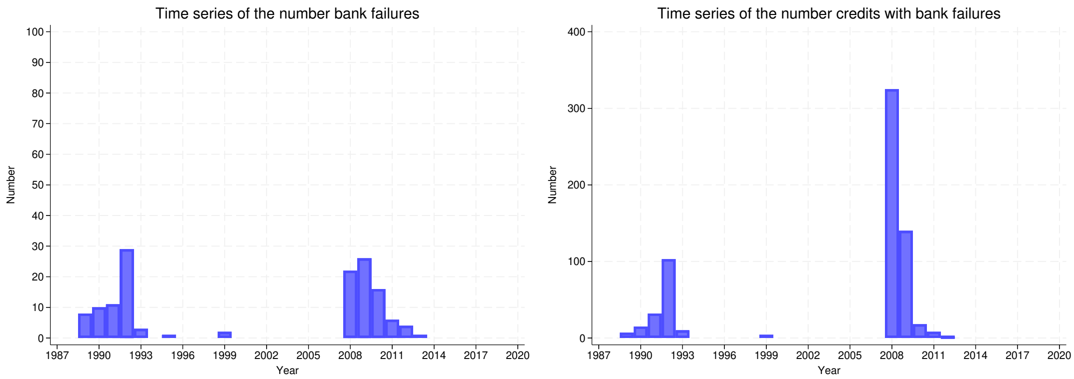

This figure plots the log of the number of investors in the syndicate and the credit line size at origination. Source: Dealscan

**Figure 3: Lending Relationships and loan shares & syndicate exit decisions**



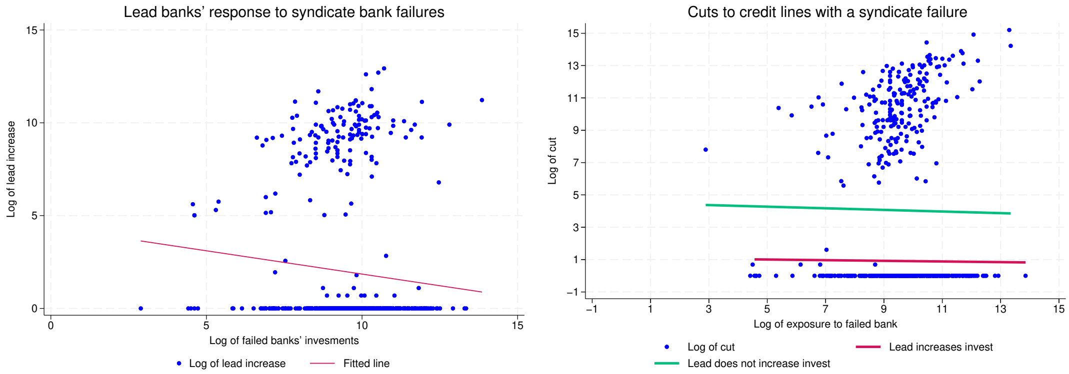

Left figure plots investors' loan shares against the length of their lending relationships with borrowers at the tine of the credit line origination. Fitted line in that figure is estimated with credit fixed effects. Box plots on the right figure plot the age of the relationship the lender had with the borrower as of the year prior to leaving the credit line syndicate. Source: SNC

**Figure 4: Credit lines that experience a syndicate-member failure**



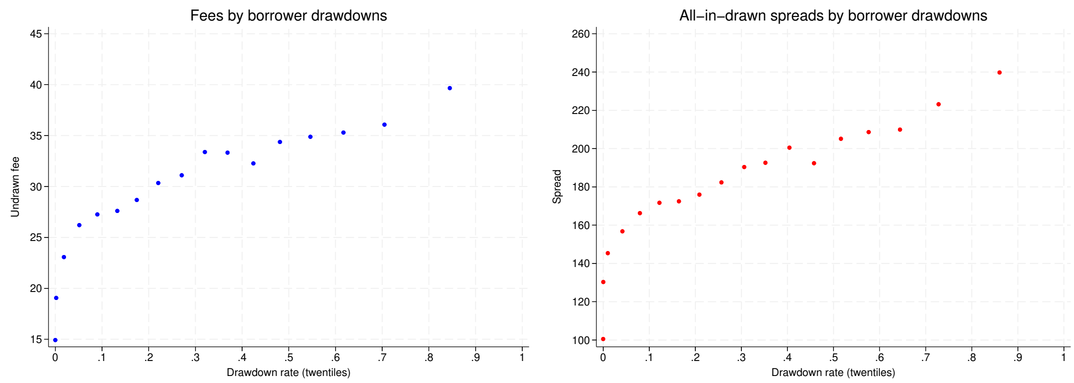

Left figure plots the time series of syndicate member failures (including Bear Sterns and Lehman Brothers). Source: FDIC Right figure plots the number of credit lines these banks were present at in the year they failed. Source: SNC

**Figure 5: Lead banks' responses and credit lines' cuts when a syndicate-member fails**



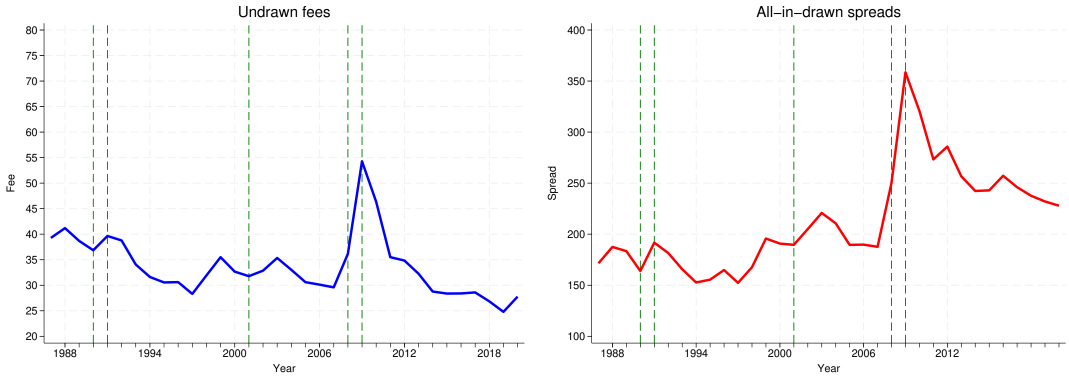

Left figure plots the log of lead bank's additional investment in the year of a syndicate member failure against the log of the loan investment of the failed bank(s). Right figure plots that same set of credit lines, the log of one plus the reduction in their commitment size in the year of failure against the log of the loan investment of the failed bank(s), distinguishing the instances when the lead bank increases its loan investment at that time from those whenm it does not. Source: SNC

**Figure 6: Fees and spreads on credit lines and past drawdown rates**



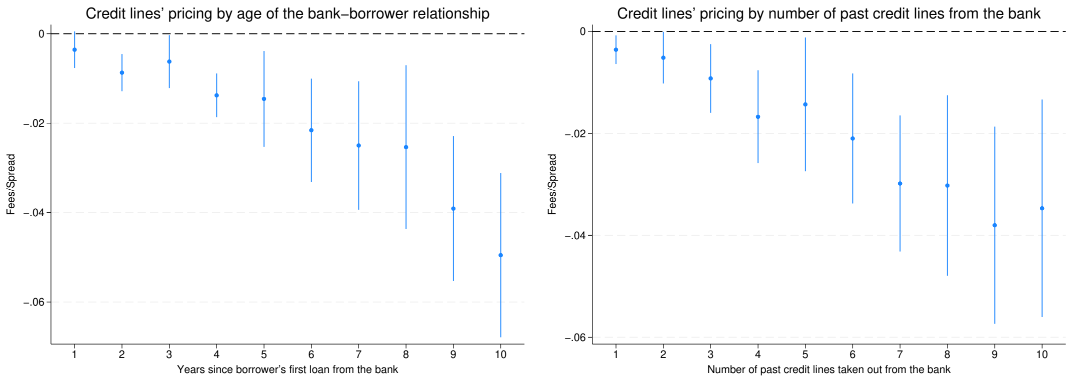

This figure plots undrawn fees and all-in-drawn spreads on new credit lines against the average drawdown rate the borrowing firm had on the three years prior to the new credit line. Source: SNC, Dealscan

**Figure 7: Fees and spreads on credit lines over the business cycle**




This figure plots the annual averages of undrawn fees and all-in-drawn spreads (over Libor) on new credit lines over time. Source: Dealscan

**Figure 8: Fees/spreads as the bank-borrower relationship ages**




Left figure plots the estimated coefficients of a model of the ratio between undrawn fees to all-in-drawn spread on dummy variables for the length of the bank-borrower relationship controlling for loan-, bank-, borrower-, and time-specific factors, and estimated with bank-borrower fixed effects. Right figure plots coefficients for dummy variables for the order of the loan in the relationship between the bank and the borrower, estimated with the same set of controls and fixed effects. Source: Dealscan

Table 1 Summary statistics for the credit lines[a]

| Panel A: Credit lines in Dealscan | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Variables | N | Mean | SD | 10th | 50th | 90th | Variables | 0% | 1% |
| UNDRAWN FEE | 29,583 | 26.15 | 17.64 | 7.00 | 22.50 | 50.00 | SECURED | 73.23 | 36.77 |
| ALL-IN-DRAWN SPD | 32,826 | 155.06 | 101.28 | 37.50 | 137.50 | 280.00 | SENIOR | 0.01 | 99.99 |
| $\frac{UNDRAWN\ FEE}{ALL-IN-DRAWN\ SPD}$ | 29,583 | 0.20 | 0.10 | 0.11 | 0.18 | 0.31 | DIV REST | 70.73 | 39.27 |
| AMOUNT($M) | 29,583 | 788.45 | 1270.75 | 40.00 | 250.00 | 2,000.00 | GUARANTOR | 90.45 | 9.55 |
| MATURITY | 29,583 | 4.08 | 2.24 | 1 | 5 | 5 | REFINANCE | 26.67 | 74.33 |
| LENDERS | 29,583 | 11.46 | 8.87 | 2 | 9 | 23 | WORKCAP | 84.49 | 15.51 |
| DRAWDOWN | 25,278 | 21.25 | 27.37 | 0.00 | 6.61 | '65.70 | DEBT REPAY | 0.88 | 0.12 |
| | | | | | | | M&A | 91.44 | 8.56 |
| | | | | | | | CP BACKUP | 93.68 | 6.32 |
| | | | | | | | CORP PURP | 41.58 | 52.42 |
| SALES($B) | 29,583 | 12.25 | 36.30 | 0.21 | 2.46 | 25.22 | AAA | 99.19 | 0.81 |
| LEVERAGE | 29,583 | 0.31 | 0.19 | 0.08 | 0.30 | 0.54 | AA | 97.53 | 2.47 |
| TANGIBLES | 29,583 | 0.71 | 0.38 | 0.22 | 0.71 | 1.20 | A | 86.54 | 13.46 |
| PROFMARGIN | 29,583 | 0.04 | 0.15 | -0.03 | 0.05 | 0.14 | BBB | 78.44 | 21.56 |
| LINTCOV | 29,583 | 2.26 | 1.03 | 1.20 | 2.12 | 3.52 | BB | 86.22 | 13.78 |
| STOCKRET | 29,583 | 0.0003 | 0.002 | -0.001 | 0.0002 | 0.002 | B | 93.18 | 6.82 |
| STOCKVOL | 29,583 | 0.02 | 0.02 | 0.01 | 0.02 | 0.04 | CCC | 99.62 | 0.38 |
| ADVERTISING | 29,583 | 0.01 | 0.02 | 0.00 | 0.00 | 0.04 | | | |
| R&D | 29,583 | 0.02 | 0.04 | 0.00 | 0.00 | 0.05 | | | |
| MKTOBOOK | 29,583 | 1.73 | 0.90 | 1.00 | 1.45 | 2.77 | | | |
| $RELAT_{Agey}$ | 29,583 | 4.18 | 5.21 | 0 | 2 | 12 | | | |
| ASSETSbk($B) | 29,583 | 998.11 | 880.45 | 65.75 | 679.77 | 2,289.24 | | | |
| CAPITALbk | 29,583 | 0.09 | 0.03 | 0.06 | 0.09 | 0.12 | | | |
| DEPOSITbk | 29,583 | 0.56 | 0.15 | 0.39 | 0.56 | 0.73 | | | |
| SUBDEBTbk | 29,583 | 0.02 | 0.01 | 0.01 | 0.02 | 0.03 | | | |
| LIQUITYbk | 29,583 | 0.22 | 0.07 | 0.13 | 0.21 | 0.30 | | | |
| ROAbk | 29,583 | 0.0023 | 0.0016 | 0.0005 | 0.0026 | 0.0037 | | | |
| ROAbkVOL | 29,583 | 0.0012 | 0.0012 | 0.0003 | 0.0008 | 0.0024 | | | |
| Panel B: Credit lines in SNC | | | | | | | | | |
| Variables | N | Mean | SD | 10th | 50th | 90th | Variables | 0% | 1% |
| DRAWDOWN RATE | 146,151 | 36.94 | 36.76 | 0 | 27.77 | 98.09 | LOANIG | 11.22 | 88.78 |
| LEAD SH | 146,151 | 24.97 | 19.10 | 0.00 | 21.67 | 50.00 | CUT | 79.23 | 11.91 |
| AMOUNT($M) | 146,151 | 265.44 | 554.34 | 20.00 | 100.00 | 600.00 | WORKCAP | 54.05 | 45.95 |
| MATURITYLEFT | 146,151 | 3.51 | 2.01 | 1 | 3 | 6 | M&A | 92.46 | 7.54 |
| LENDERS | 146,151 | 8.98 | 11.73 | 3 | 6 | 18 | RECAP | 98.62 | 1.38 |
| | | | | | | | DEBTREPAY | 97.85 | 2.15 |
| SHARE | 1,444,113 | 10.68 | 10.22 | 1.53 | 7.27 | 25.00 | EXIT | 72.81 | 2.09 |
| $RELAT_{Agey}$ | 1,444,113 | 3.40 | 4.52 | 0 | 2 | 9 | $RELAT_{Aged}$ | 26.95 | 73.05 |

[a] This table reports summary statistics for the credit lines in Dealscan (Panel A) and SNC (Panel B) that we use in our paper. Percentages for the variables CUT and EXIT do not add up to 1 because these variables are not defined for the first year of the credit line. See Appendix A for the definitions of the variables.

Table 2 Number of syndicate participants and loan size[a]

| Variables | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| $LAMOUNT$ | 0.253*** | 0.200*** | 0.157*** | 0.247*** | 0.197*** | 0.154*** |
| | (10.39) | (11.53) | (11.86) | (10.07) | (11.31) | (11.65) |
| $RECESSION \times LAMOUNT$ | | | | 0.096*** | 0.063*** | 0.054*** |
| | | | | (5.42) | (4.48) | (4.03) |
| constant | 0.247 | 0.151 | -0.014 | 0.262 | 0.159 | 0.006 |
| | (0.91) | (0.66) | (-0.02) | (0.97) | (0.70) | (0.01) |
| Observations | 32826 | 31334 | 27477 | 32826 | 31334 | 27477 |
| R-squared | 0.543 | 0.684 | 0.729 | 0.545 | 0.685 | 0.729 |
| Firm FE | NO | YES | NO | NO | YES | NO |
| Bank-Firm FE | NO | NO | YES | NO | NO | YES |

[a] The dependent variable in this table is the log of the number of participants (lead plus non-lead members) in the syndicate at the time of the loan origination. $LAMOUNT$ is the log amount of the credit line. $RECESSION$ is a dummy variable equal to one for credit lines taken out during the NBER recessions. All of the models include the sets of borrower-, loan-, and bank-specific factors reported in Table 1 as well as dummy variables to account for the borrower activity as defined by 1-digit SIC codes, and time (year-quarter) dummy variables. Models estimated with robust standard errors clustered by bank and by firm. We report t statistics in parentheses. *** denotes 1% significant level, ** denotes 5% significant level, and * denotes 10% significant level.
Source: Dealscan

Table 3 Banks' relationships with borrowers and their credit line investments[a]

| Panel A: Investments at the time of the credit line origination | | | | | |
|---|---|---|---|---|---|
| Variables | 1 | 2 | 3 | 4 | 5 |
| $RELAT_{Aged}$ | 0.011*** | | | | |
| | (29.80) | | | | |
| $RELAT_{Agey}$ | | 0.001*** | | | |
| | | (9.79) | | | |
| $RELAT_{TLd}$ | | | 0.009*** | | |
| | | | (4.63) | | |
| $RELAT_{TLsh}$ | | | | 0.448*** | |
| | | | | (28.72) | |
| $RELAT_{BKTLsh}$ | | | | | 0.594*** |
| | | | | | (18.81) |
| $LEAD$ | 0.052*** | 0.052*** | 0.052*** | 0.051*** | 0.052*** |
| | (30.21) | (30.24) | (31.02) | (30.06) | (30.81) |
| constant | 0.114*** | 0.119*** | 0.119*** | 0.113*** | 0.120*** |
| | (4.22) | (4.47) | (4.59) | (4.66) | (4.59) |
| Observations | 346907 | 346907 | 346907 | 346907 | 346907 |
| R-squared | 0.806 | 0.806 | 0.806 | 0.811 | 0.806 |
| Credit-Year FE | YES | YES | YES | YES | YES |
| Bank-Year FE | YES | YES | YES | YES | YES |
| Panel B: Investments over the years the credit line is alive | | | | | |
| Variables | 1 | 2 | 3 | 4 | 5 |
| $RELAT_{Aged}$ | 0.011*** | | | | |
| | (19.64) | | | | |
| $RELAT_{Agey}$ | | 0.001*** | | | |
| | | (9.67) | | | |
| $RELAT_{TLd}$ | | | 0.007*** | | |
| | | | (4.96) | | |
| $RELAT_{TLsh}$ | | | | 0.412*** | |
| | | | | (25.87) | |
| $RELAT_{BKTLsh}$ | | | | | 0.543*** |
| | | | | | (24.45) |
| $LEAD$ | 0.058*** | 0.058*** | 0.058*** | 0.057*** | 0.058*** |
| | (38.95) | (38.21) | (40.48) | (40.23) | (40.02) |
| constant | 0.091*** | 0.099*** | 0.100*** | 0.098*** | 0.100*** |
| | (23.85) | (26.75) | (27.15) | (27.31) | (27.06) |
| Observations | 1408503 | 1408503 | 1408503 | 1408503 | 1408503 |
| R-squared | 0.787 | 0.787 | 0.786 | 0.791 | 0.787 |
| Credit-Year FE | YES | YES | YES | YES | YES |
| Bank-Year FE | YES | YES | YES | YES | YES |

[a] The dependent variable in this table is the share of the credit line owned by a participant bank in the credit line syndicate. $RELAT_{Aged}$ is a dummy variable equal to one if the bank has granted credit to the borrower in the past during the sample period. $RELAT_{Agey}$ is the number of years since the bank first granted funding to the borrower during the sample period. $RELAT_{TLd}$ is a dummy variable equal to one if the bank is also funding the borrower's term loans. $RELAT_{TLsh}$ is the share of the borrower's outstanding term loans that the bank is funding. $RELAT_{BKTLsh}$ is the percentage of the bank's total term loan funding allocated to the borrower's term loans. $LEAD$ is a dummy variable for the lead bank in the credit line syndicate. Models estimated with credit-year and bank-year fixed effects and with robust standard errors clustered by credit and year. We report t statistics in parentheses. *** denotes 1% significant level, ** denotes 5% significant level, and * denotes 10% significant level.
Source: SNC.

Table 4 Banks' syndicate exits and relationships with borrowers[a]

| Variables | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| $RELAT_Aged$ | -0.008*** | | | | |
| | (-6.88) | | | | |
| $RELAT_Agey$ | | -0.000*** | | | |
| | | (-4.19) | | | |
| $RELAT_TLd$ | | | -0.003*** | | |
| | | | (-2.91) | | |
| $RELAT_TLsh$ | | | | -0.064*** | |
| | | | | (-3.93) | |
| $RELAT_BKTLsh$ | | | | | -0.149*** |
| | | | | | (-3.09) |
| LEAD | -0.010*** | -0.010*** | -0.010*** | -0.010*** | -0.010*** |
| | (-5.28) | (-5.45) | (-5.54) | (-5.44) | (-5.55) |
| $LINVEST$ | 0.001 | 0.001 | 0.001 | 0.001 | 0.001 |
| | (1.43) | (1.30) | (1.24) | (1.48) | (1.27) |
| constant | 0.029 | 0.026 | 0.024 | 0.024 | 0.023 |
| | (0.59) | (0.53) | (0.48) | (0.49) | (0.47) |
| Observations | 777785 | 777617 | 777785 | 777785 | 777785 |
| R-squared | 0.557 | 0.557 | 0.557 | 0.557 | 0.557 |
| Credit-Year FE | YES | YES | YES | YES | YES |
| Bank-Year FE | YES | YES | YES | YES | YES |

[a] The dependent variable in this table is a dummy variable equal to one in year t for banks that were in the syndicate in year $t-1$ but are not there in year t. $RELAT_Aged$ is a dummy variable equal to one if the bank has granted credit to the borrower in the past during the sample period. $RELAT_Agey$ is the number of years since the bank first granted funding to the borrower during the sample period. $RELAT_TLd$ is a dummy variable equal to one if the bank is also funding the borrower's term loans. $RELAT_TLsh$ is the share of the borrower's outstanding term loans that the bank is funding. $RELAT_BKTLsh$ is the percentage of the bank's total term loan funding allocated to the borrower's term loans. $LEAD$ is a dummy variable for the lead bank in the credit syndicate. $LINVEST$ is the log of the dollar amount the participant bank has invested in the credit line. All independent variables are measured as of year t-1. Models estimated with credit-year and bank-year fixed effects and with robust standard errors clustered by credit and year. We report t statistics in parentheses. *** denotes 1% significant level, ** denotes 5% significant level, and * denotes 10% significant level.
Source: SNC.

Table 5 Lead banks' response to syndicate-member failures[a]

| Panel A: Participants' additional investment likelihood following a syndicate-member failure | | | | |
|---|---|---|---|---|
| Variables | 1 | 2 | 3 | 4 |
| $LEAD$ | 0.027*** | 0.012*** | 0.002 | 0.009*** |
| | (7.86) | (4.05) | (1.01) | (4.31) |
| $LEAD{\times}FAIL$ | 0.015 | 0.010 | 0.004 | 0.001 |
| | (1.43) | (1.13) | (0.47) | (0.14) |
| $LEAD{\times}FAILY$ | 0.056** | 0.068*** | 0.064*** | 0.042* |
| | (2.40) | (3.16) | (3.29) | (1.71) |
| $RELAT_{Agedy}$ | -0.001 | -0.001** | -0.001*** | -0.001** |
| | (-1.69) | (-2.24) | (-4.20) | (-2.57) |
| $LINVEST$ | -0.016*** | 0.001 | -0.009*** | -0.013*** |
| | (-5.96) | (0.84) | (-5.92) | (-10.09) |
| constant | 0.349*** | 0.181*** | 0.285*** | 0.323*** |
| | (12.45) | (11.60) | (19.33) | (25.70) |
| Observations | 833896 | 831952 | 828905 | 810459 |
| R-squared | 0.201 | 0.624 | 0.636 | 0.661 |
| CREDIT FE | YES | NO | NO | NO |
| CREDIT-YEAR FE | NO | YES | YES | YES |
| Bank FE | NO | NO | YES | NO |
| Bank-YEAR FE | NO | NO | NO | YES |
| **Panel B: Participants' additional investment following a syndicate-member failure** | | | | |
| Variables | 1 | 2 | 3 | 4 |
| $LEAD$ | 0.019*** | 0.009*** | 0.002 | 0.006*** |
| | (7.86) | (4.05) | (1.01) | (4.31) |
| $LEAD{\times}FAIL$ | 0.010 | 0.007 | 0.003 | 0.001 |
| | (1.43) | (1.13) | (0.47) | (0.14) |
| $LEAD{\times}FAILY$ | 0.039** | 0.047*** | 0.045*** | 0.029* |
| | (2.40) | (3.16) | (3.29) | (1.71) |
| $RELAT_{Agey}$ | -0.001 | -0.000** | -0.001*** | -0.000** |
| | (-1.69) | (-2.24) | (-4.20) | (-2.57) |
| $LINVEST$ | -0.011*** | 0.001 | -0.006*** | -0.009*** |
| | (-5.96) | (0.84) | (-5.92) | (-10.09) |
| constant | 0.242*** | 0.126*** | 0.198*** | 0.224*** |
| | (12.45) | (11.60) | (19.33) | (25.70) |
| Observations | 833896 | 831952 | 828905 | 810459 |
| R-squared | 0.201 | 0.624 | 0.636 | 0.661 |
| CREDIT FE | YES | NO | NO | NO |
| CREDIT-YEAR FE | NO | YES | YES | YES |
| BANK FE | NO | NO | YES | NO |
| BANK-YEAR FE | NO | NO | NO | YES |

[a] The dependent variable the top panel is a dummy variable equal to one when the participant increases its loan investment in the credit line over the year. The dependent variable in the bottom panel is the log of one plus the additional investment the participant bank makes in the credit line over the year. $LEAD$ is a dummy variable for the lead bank in the credit syndicate. $FAIL$ is a dummy variable equal to one for credit lines that experience the default of one of its syndicate members during their life. $FAILY$ is a dummy variable equal to one for the year in which the credit line experiences the failure of a syndicate member. $RELAT_{Agey}$ is the (lagged) number of years since the bank first granted funding to the borrower during the sample period. $LINVEST$ is the log of the participant's loan investment (lagged). Models estimated with robust standard errors clustered by credit and time (year). We report t statistics in parentheses. *** denotes 1% significant level, ** denotes 5% significant level, and * denotes 10% significant level.
Source: SNC.

Table 6 Cuts of credit lines following the failure of syndicate member banks[a]

| Panel A: Likelihood of credit line's cut following a syndicate-member failure | | | |
|---|---|---|---|
| Variables | 1 | 2 | 3 |
| $FAIL$ | | 0.011 | |
| | | (1.44) | |
| $FAILY$ | 0.045** | 0.091*** | 0.047** |
| | (2.28) | (4.27) | (2.32) |
| $L\Delta LEADINVEST$ | -0.011*** | -0.014*** | -0.011*** |
| | (-15.24) | (-15.96) | (-15.50) |
| $L\Delta LEADINVEST{\times}FAIL$ | 0.001 | 0.000 | 0.001 |
| | (0.58) | (0.12) | (0.78) |
| $L\Delta LEADINVEST{\times}FAILY$ | -0.010*** | -0.015*** | -0.009*** |
| | (-3.19) | (-5.85) | (-2.75) |
| $RELAT_{Agey}$ | -0.001 | -0.007*** | -0.002 |
| | (-1.18) | (-4.05) | (-1.35) |
| $LLEADINVEST$ | -0.006*** | -0.003*** | -0.006*** |
| | (-5.93) | (-3.57) | (-5.36) |
| constant | -0.766*** | 1.020*** | -1.070*** |
| | (-4.94) | (12.29) | (-5.04) |
| Observations | 81092 | 89611 | 79842 |
| R-squared | 0.470 | 0.123 | 0.481 |
| CREDIT FE | YES | NO | NO |
| BANK FE | NO | YES | NO |
| BANK-CREDIT FE | NO | NO | YES |
| p for $H_0$ : | | | |
| $FAILY + L\Delta LEADINVEST{\times}FAILY = 0$ | 0.0412 | 0.0001 | 0.0303 |
| **Panel B: Size of credit lines' cuts following a syndicate-member failure** | | | |
| Variables | 1 | 2 | 3 |
| $FAIL$ | | 0.134 | |
| | | (1.54) | |
| $FAILY$ | 0.494** | 0.993*** | 0.513** |
| | (2.04) | (4.09) | (2.04) |
| $L\Delta LEADINVEST$ | -0.108*** | -0.136*** | -0.110*** |
| | (-19.35) | (-20.56) | (-19.90) |
| $L\Delta LEADINVEST{\times}FAIL$ | -0.014 | -0.016* | -0.012 |
| | (-1.06) | (-1.68) | (-0.96) |
| $L\Delta LEADINVEST{\times}FAILY$ | -0.101*** | -0.155*** | -0.098** |
| | (-2.72) | (-5.28) | (-2.35) |
| $RELAT_{Agey}$ | -0.015*** | -0.082*** | -0.021 |
| | (-3.09) | (-4.47) | (-1.54) |
| $LLEADINVEST$ | -0.057*** | -0.034*** | -0.060*** |
| | (-5.99) | (-3.66) | (-5.53) |
| constant | -10.493*** | 7.814*** | -13.842*** |
| | (-6.29) | (10.56) | (-6.13) |
| Observations | 81107 | 89623 | 79857 |
| R-squared | 0.434 | 0.110 | 0.446 |
| CREDIT FE | YES | NO | NO |
| BANK FE | NO | YES | NO |
| BANK-CREDIT FE | NO | NO | YES |
| p for $H_0$ : | | | |
| $FAILY + L\Delta LEADINVEST{\times}FAILY = 0$ | 0.0607 | 0.0002 | 0.0521 |

[a] The dependent variable the top panel is a dummy variable equal to one when credit lines experience a reduction over the year. The dependent variable in the bottom panel is the log of one plus the cut in the credit line over the year. $L\Delta LEADINVEST$ is the log of one plus the additional credit investment the lead bank makes over the year. $FAIL$ is a dummy variable equal to one for credit lines that experience the default of one of its syndicate members during their life. $FAILY$ is a dummy variable equal to one for the year in which the credit line experiences the failure of a syndicate member. $RELAT_{Agey}$ is the (lagged) number of years since the bank first granted funding to the borrower during the sample period. $LLEADINVEST$ is the log of one plus the lead bank lagged investment in credit line. Models estimated with robust standard errors clustered by credit and time (year). We report t statistics in parentheses. *** denotes 1% significant level, ** denotes 5% significant level, and * denotes 10% significant level.

Table 7 Undrawn fees and all-in-drawn-spreads versus borrowers' past drawdowns[a]

| | Panel A: Undrawn fees | | | Panel B: All-in-drawn spread | | | Panel C: $\frac{Undrawnfee}{All-in-drawnspread}$ | | |
|---|---|---|---|---|---|---|---|---|---|
| Variables | 1 | 2 | 3 | 4 | 5 | 6 | 7 | 8 | 9 |
| $DRAWDOWN$ | 4.477*** | 4.992*** | 5.162*** | 4.477*** | 27.506*** | 27.339*** | -0.003 | 0.005 | 0.005 |
| | (5.80) | (4.86) | (5.02) | (5.80) | (5.34) | (4.88) | (-0.59) | (0.72) | (0.73) |
| constant | 24.203** | 50.868*** | -163.209*** | 24.203** | 292.034*** | -413.464*** | 0.156 | 0.113** | -0.876*** |
| | (2.37) | (11.39) | (-5.77) | (2.37) | (11.28) | (-3.32) | (1.50) | (2.48) | (-4.00) |
| Observations | 19115 | 18567 | 16472 | 19115 | 20237 | 18131 | 18473 | 17925 | 15849 |
| R-squared | 0.661 | 0.809 | 0.836 | 0.661 | 0.820 | 0.848 | 0.373 | 0.556 | 0.650 |
| Borrower FE | NO | YES | NO | NO | NO | YES | NO | NO | YES |
| Bank-borrower FE | NO | NO | YES | NO | NO | YES | NO | NO | YES |

[a] Dependent variable in Panel A is the undrawn fee borrowers pay when they take out a credit line. Dependent variable in Panel B is the all-in-drawn spread over Libor that borrowers pay on the funds they drawdown on their credit lines. Dependent variable in Panel C is the ratio between the undrawn fee and the All-in-drawn spread on the same credit line. $DRAWDOWN$ is average of the drawdown rate on the borrower's credit credit line in the three years prior to taking out the new credit line. All of the models include the sets of borrower-, loan-, and bank-specific factors reported in Table 1 as well as the three-month Libor and triple-B over triple-A corporate bond spread at the time of the credit line origination and year-quarter fixed effects. Models estimated with robust standard errors clustered by borrower and by bank. We report t statistics in parentheses. *** denotes 1% significant level, ** denotes 5% significant level, and * denotes 10% significant level.
Source: Dealscan and SNC.

Table 8 Undrawn fees relative to All-in-drawn spreades over the business cycle[a]

| Variables | 1 | 2 | 3 |
|---|---|---|---|
| *RECESSION* | 0.010*** | 0.011*** | 0.010*** |
| | (2.85) | (3.00) | (2.85) |
| constant | 0.288*** | 0.430*** | 0.288*** |
| | (5.43) | (7.85) | (5.43) |
| Observations | 23558 | 27026 | 23558 |
| R-squared | 0.620 | 0.491 | 0.620 |
| Borrower FE | NO | YES | NO |
| Bank-borrower FE | NO | NO | YES |

[a] The dependent variable in this table is the ratio between the undrawn fee and the All-in-drawn spread on the same credit line. *RECESSION* is a dummy variable equal to one for the three recessions as classified by NBER during our sample period (1987-2020). All of the models include the sets of borrower-, loan-, and bank-specific factors reported in Table 1 as well as dummy variables to account for the borrower activity as defined by 1-digit SIC codes. Models estimated with robust standard errors clustered by borrower and by bank. We report t statistics in parentheses. *** denotes 1% significant level, ** denotes 5% significant level, and * denotes 10% significant level.
Source: Dealscan

Table 9 Credit line's undrawn fee over all-in-drawn spread and bank-borrower lending relationship[a]

| Variables | 1 | 2 | 3 | 4 | 5 | 6 |
|---|---|---|---|---|---|---|
| $RELAT_{Agey}$ | -0.001*** | -0.001*** | -0.006*** | | | |
| | (-3.85) | (-3.71) | (-9.35) | | | |
| $RELAT_{Number}$ | | | | -0.001*** | -0.001*** | -0.004*** |
| | | | | (-3.12) | (-2.65) | (-4.03) |
| constant | 0.288*** | 0.651*** | 0.288*** | 0.290*** | 0.657*** | 0.629*** |
| | (2.73) | (5.58) | (5.43) | (2.74) | (5.63) | (9.79) |
| Observations | 28384 | 28345 | 23558 | 28384 | 28345 | 23558 |
| R-squared | 0.257 | 0.310 | 0.620 | 0.256 | 0.310 | 0.615 |
| Bank FE | NO | YES | NO | NO | NO | YES |
| Bank-borrower FE | NO | NO | YES | NO | NO | YES |

[a] Dependent variable in this table is the ratio between the undrawn fee and the all-in-drawn spread on the credit line. $RELAT_{Agey}$ is the number of years between the current credit line and the first time the current lead bank lent to the borrower (either through a credit line or term loan) during the sample period (1987-2020). $RELAT_{Number}$ is the number of times since 1987 that the borrower has taken out loans from the lead bank prior to the current loan. All of the models include the sets of borrower-, loan-, and bank-specific factors reported in Table 1 as well as dummy variables to account for the borrower activity as defined by 1-digit SIC codes. In addition, we control for the triple-B over triple-A bond spread at the time of the credit line origination. Models estimated with robust standard errors clustered by borrower and by bank. We report t statistics in parentheses. *** denotes 1% significant level, ** denotes 5% significant level, and * denotes 10% significant level.
Source: Dealscan.

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# Appendix: Variable Definitions

This table provides definitions of the variables used in the empirical analysis.

| VARIABLE | DEFINITION | SOURCE |
|---|---|---|
| | **FIRM CONTROLS** | |
| $AA, AA, ....C$ | Credit rating of the borrower | Compustat |
| $ADVERTISING$ | Advertising expenses over sales | Compustat |
| $EX\ RET$ | Return on the borrower's stock over the market return | CRSP |
| $LEVERAGE$ | Debt over assets | Compustat |
| $LINTCOV$ | Log of interest coverage truncated at 0 | Compustat |
| $LIQUIDITY$ | Cash over asset | Compustat |
| $MKTOBOOK$ | Market to book value | Compustat |
| $PROF\ MARGIN$ | Net income over sales | Compustat |
| $RELAT_{Aged}$ | Dummy variable equal to one if the bank has granted credit to the borrower in the past during the sample period | SNC |
| $RELAT_{Agey}$ | Number of years since the bank first granted funding to the borrower during the sample period | Compustat & SNC |
| $RELAT_{Number}$ | Number of credit lines the borrower has taken out from the lead bank during the sample period | SNC |
| $RELAT_{TLd}$ | Dummy variable equal to one if the bank is also funding the borrower's term loans | SNC |
| $RELAT_{TLsh}$ | Share of the borrower's outstanding term loans that the bank is funding | SNC |
| $RELAT_{BKTLsh}$ | Percentage of the bank's total term loan funding allocated to the borrower's term loans | SNC |
| $R\&D$ | Research and development expenses over sales | Compustat |
| $SALES$ | Sales in billions dollars | Compustat |
| $STOCK\ VOL$ | Standard deviation of the borrower's stock return | CRSP |
| $TANGIBLES$ | Share of assets in tangibles | Compustat |
| | **LOAN CONTROLS** | |
| $ALL-IN-DRAWN$ | All-in-drawn spread on the credit line at origination | Dealscan |
| $AMOUNT$ | Loan amount in million dollars | Dealscan |
| $CP\ BCKUP$ | Dummy variable equal to 1 if the credit line is for a CP program | Dealscan |
| $CUT$ | Dummy variable equal to 1 if the credit line experiences a reduction in its size over the year | SNC |
| $DEBT\ REPAY$ | Dummy variable equal to 1 if the credit line is to repay existing debt | Dealscan |
| $DIVIDEND\ REST$ | Dummy variable equal to 1 if there are dividend restrictions | Dealscan |
| $DRAWDOWN$ | Average drawdown rate on borrower's credit lines over the past three years | SNC |
| $DRAWDOWN\ RATE$ | Percentage of the credit line already drawn down | SNC |
| $FULLY\ DRAWN$ | Dummy variable equal to 1 for credit lines with a drawdown rate equal or larger than 95% | SNC |
| $GUARANTOR$ | Dummy variable equal to 1 if the borrower has a guarantor | Dealscan |
| $LOANIG$ | Dummy variable equal to 1 if the loan is rated PASS by the lead arranger | SNC |
| $M\&A$ | Dummy variable equal to 1 if the credit line is for M&A activity | Dealscan |
| $MATURITY$ | Maturity of the loan at origination in years | SNC |
| $MATURITYLEFT$ | Maturity left in the loan in years | SNC |
| $PROJFIN$ | Dummy variable equal to 1 if the credit line is for project finance | Dealscan |

| VARIABLE | DEFINITION | SOURCE |
|---|---|---|
| *REFINANCE* | Dummy variable equal to 1 if the loan is to refinance an existing loan | Dealscan |
| *SECURED* | Dummy variable equal to 1 if the loan is secured | Dealscan |
| *SENIOR* | Dummy variable equal to 1 if the loan is senior | Dealscan |
| *UNDRAW FEE* | Undrawn fee on the credit line at origination | Dealscan |
| *UNDRAWN RATE* | Percentage of the credit line still unused | SNC |
| *WORK CAPITAL* | Dummy variable equal to 1 if the credit line is for working capital | Dealscan |
| | **SYNDICATE CONTROLS** | |
| *EXIT* | Dummy variable equal to 1 if a lender leaves the syndicate (between consecutive years) | SNC |
| *EXITsh* | Percentage of lenders that leave the credit line syndicate (between consecutive years) | SNC |
| *LENDERS* | Number of investors in the syndicate at origination | Dealscan & SNC |
| *FAILURE* | Dummy variable equal to 1 if there was a failure of a syndicate member bank over the year | FDIC |
| *FAILURE SH* | Percentage of the credit line the failed bank(s) owned at yearend prior to its failure | SNC |
| *INVEST* | Dollar amount invested by a participant in the credit line syndicate | SNC |
| *INVESTU* | Dummy variable equal to 1 if the participant increased its investment in the credit line over the year | SNC |
| $\Delta$*INVEST* | Additional investment over the year by the participant in the credit line syndicate | SNC |
| *LEAD* | Dummy variable equal to 1 if the investor is the lead arranger in the syndicate | SNC |
| *LEADINVEST* | Dollar amount invested by the lead arranger in the credit line syndicate | SNC |
| *LEADINVEST* | Additional investment over the year by the lead bank in the credit line syndicate | SNC |
| *LEAD SH* | Lead arranger's share of the loan | SNC |
| *SHARE* | Portion of the credit line owned by an investor | SNC |
| | **BANK CONTROLS** | |
| *ASSETSbk* | Bank assets in billion dollars | Y9C |
| *CAPITALbk* | Shareholders' equity capital over assets | Y9C |
| *DEPOSITSbk* | Total deposits over assets | Y9C |
| *LIQUIDITYbk* | Cash plus securities over assets | Y9C |
| *ROAbk* | Net income over assets | Y9C |
| *ROAbk VOL* | Standard deviation of the quarterly ROA computed over the last three years | Y9C |
| *SUBDEBTbk* | Subdebt over assets | Y9C |
| | **MACROECONOMIC CONTROLS** | |
| *BONDSPREAD* | Triple-B over triple-A spread in the bond market | DLX-Haver |
| *LIBOR* | 3 month Libor 3 month | DLX-Haver |
| *RECESSION* | Dummy variable equal to 1 for the recessions during the sample period (1990/91, 2001, 2008/09) | NBER |

# Internet Appendix for

# Bank Syndicates and Liquidity Provision

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## A-1 Proofs

**Proof of Proposition 1:** It is clear that the zero profit constraint (Equation 4) for banks must bind, hence $\lambda_F > 0$, thus (here $N^*$ is the first best syndicate size)

$$pL(R-r) + C = pqm(\frac{L}{N^*})L + (N^* - 1)x \tag{33}$$

which says that the expected revenues to the syndicate must be equal to the expected costs. The first order condition with respect to $N$ can be rewritten as

$$-pqm'(\frac{L}{N^*})\frac{L^2}{(N^*)^2} + x = 0 \tag{34}$$

and the second order condition

$$pq\left(m'(\frac{L}{N^*})\frac{2L^2}{(N^*)^3} + m''(\frac{L}{N^*})\frac{L^3}{(N^*)^4}\right) > 0 \tag{35}$$

and thus there is a unique perfectly competitive maximum (first best). Further since $H_R(0) > G_C > 0$, we must have $C > 0$ and $R = r$; it is cheaper to put the cost of providing the first best loan commitment in the commitment fee rather than the interest rate; hence the interest rate will be $r$. Thus the commitment fee is given by

$$C = pqm(\frac{L}{N^*})L + (N^* - 1)x \tag{36}$$

$\blacksquare$

**Proof of Proposition 2:** This is a standard convex programming problem with an objective being minimized that is convex in $C$ and $R$ and a constraint set that is affine in $R$ and $C$ and convex in $N$. The first order conditions are:

$$\text{(w.r.t to R)} \quad H_R(p(R-r)L)pL - \lambda L - \lambda pL\tfrac{\delta}{1-\delta} - \mu = 0 \tag{37}$$

$$\text{(w.r.t to C)} \quad G_C(C) - \lambda\tfrac{\delta}{1-\delta} - \gamma = 0 \tag{38}$$

$$\text{(w.r.t to N)} \quad \lambda\left[-\tfrac{\delta}{1-\delta}pqm'(\tfrac{L}{N})\tfrac{L^2}{N^2} + \tfrac{\delta}{1-\delta}x - m'(\tfrac{L}{N})\tfrac{L^2}{N^2}\right] = 0 \tag{39}$$

plus the complementary slackness conditions that

$$\lambda\left[-(R-r)L\frac{1-(1-p)\delta}{1-\delta} - \frac{\delta}{1-\delta}\left[C - pqm(\frac{L}{N})L - (N-1)x\right] + m(\frac{L}{N})L\right] = 0 \tag{40}$$

plus $\mu(R-r) = 0$ and $\gamma C = 0$. It is clear that the participation constraint must bind and $\lambda > 0$, hence (here $\hat{N}$ is the second best syndicate size):

$$(R-r)L\frac{1-(1-p)\delta}{1-\delta} + \frac{\delta}{1-\delta}\left[C - pqm(\frac{L}{\hat{N}})L - (\hat{N}-1)x\right] = m(\frac{L}{\hat{N}})L \tag{41}$$

First we note that $\hat{N} > N^*$ (more syndicate members) because Equation (39) can be rewritten as

$$pqm'(\frac{L}{\hat{N}})\frac{L^2}{(\hat{N})^2} + \frac{1-\delta}{\delta}m'(\frac{L}{\hat{N}})\frac{L^2}{(\hat{N})^2} = x \tag{42}$$

where the second term in Equation (42) did not exist without participation constraints (compare to Equation (34)) and is a positive term (the left hand side is decreasing in $N$ and the right hand side is a constant). Hence $\hat{N} > N^*$ follows. Note that increasing $L$ increases $\hat{N}$.

Let $d = \frac{\delta}{1-\delta}$. The first order conditions in Equations (37) and (38) can be merged to obtain (when $C$ is interior which it is under the assumptions we make) that:

$$\frac{H_R(p(R-r)L)}{G_C(C)} \geq \frac{1}{pd} + 1 \tag{43}$$

Note that from 1, we have assumed that $\frac{H_R(0)}{G_C} > 1$. Then there exists a $0 < \bar{\delta} < 1$ such that

$$\frac{H_R(0)}{G_C} > \frac{1-(1-p)\delta}{p\delta} = \frac{1}{pd} + 1 > 1 \text{ for } \delta \in [\bar{\delta}, 1], \tag{44}$$

we obtain that $\hat{R} = r$. We can then show the following; the profit condition implies

$$\begin{aligned}
& pL\hat{(}R - r) + C \\
& > pqm(\frac{L}{\hat{N}})L + (\hat{N} - 1)x) \text{ because expected revenues exceed costs} \\
& > pqm(\frac{L}{N^*})L + (N^* - 1)x) \text{ because costs are minimized at } N^*
\end{aligned}$$

which basically states that the budget line for the borrower must move outwards and given our assumptions that $\frac{H_R(0)}{G_C} > \frac{1}{pd} + 1$, we obtain that $\hat{C} > C$ and $\hat{R} = R$.

On the other hand if $\delta$ in $[0, \bar{\delta})$,

$$\frac{H_R(0)}{G_C} < \frac{1}{pd} + 1 \tag{45}$$

we have that $\hat{R} > r$. Note that Equation (44) is satisfied only for $\delta < \bar{\delta}$, $0 < \bar{\delta} < 1$. This is intuitive, for high discount rates, $\delta$, the future is more valuable and thus commitment fees in the future suffice. In contrast, with low discount rates, future profits are less valuable and incomplete insurance in unavoidable. We know that at $\bar{\delta}$, $R = r$ and $C > 0$. If we can show that $\frac{dC}{d\delta} < 0$ when $R > 0$, then decreasing $\delta$ increases $C$, i.e., $C(\delta) > C^*$ for all $\delta$.

When $\delta < \bar{\delta}$, Equation (44) determines $R$, and $C$ is determined by the budget constraint, Equation (41).

Rearranging Equation (37) and setting $G_C = k$, a constant, and using Equation (38), we obtain that

$$\begin{aligned}
H_R(p(\hat{R} - r)L) &= k(\frac{1}{pd} + 1) && (46) \\
p(\hat{R} - r)L &= H_R^{-1}\left(k(\frac{1}{pd} + 1)\right). && (47)
\end{aligned}$$

Using Equation (41), we obtain that

$$H_R^{-1}\left(k(\frac{1}{pd} + 1)\right)(\frac{1}{pd} + 1) + C - \frac{1}{d}m(\frac{L}{\hat{N}})L = pqm(\frac{L}{\hat{N}})L + (\hat{N} - 1)x. \tag{48}$$

Differentiating with respect to $\delta$ (and noting that the dependence of $\hat{N}$ on $\delta$ can be ignored due to the envelope theorem), we obtain that

$$\frac{1}{(1+\delta)^2}\left[-\frac{1}{d^2}\frac{k}{p}\frac{dH_R^{-1}}{dR}\left(k(\frac{1}{pd}+1)\right)(\frac{1}{pd}+1)-\frac{1}{d^2}\frac{1}{p}H_R^{-1}\left(k(\frac{1}{pd}+1)\right)+\frac{dC}{d\delta}+\frac{1}{d^2}m(\frac{L}{\hat{N}})L\right]=0. \quad (49)$$

Using the inverse function theorem ($H_R()$ in an increasing function), we can rearrange Equation (49) to obtain that:

$$\frac{dC}{d\delta}=-\frac{1}{d^2}\left[m(\frac{L}{\hat{N}})L-(\hat{R}-r)L-\frac{1}{p}\frac{H_R(p(\hat{R}-r)L)}{H_{RR}(p(\hat{R}-r)L)}\right]<0$$

if and only if

$$\frac{m(\frac{L}{\hat{N}})L}{(\hat{R}-r)L}>1+\frac{H_R(p(\hat{R}-r)L)}{p(\hat{R}-r)LH_{RR}(p(\hat{R}-r)L)} \quad (50)$$

from which the condition in the theorem follows because $\hat{C}(\delta)\geq\hat{C}(\delta=\bar{\delta})=\hat{C}(\delta=1)\geq C^*$ (note the first best commitment fee $C^*$ does not depend on $\delta$).

Notice that since profits are strictly positive, $m(\frac{L}{\hat{N}})L>(\hat{R}-r)L$ and the ratio on the left hand side is strictly bigger than 1. In the case where $H(t)=(\beta+t)^\zeta$, $\zeta>1, \zeta\beta^{\zeta-1}>k$, we have that $H_R(0)=\zeta\beta^{\zeta-1}$ and thus the condition that $\frac{H_R(0)}{G_C}>1$ is satisfied. However, $\frac{H_R(0)}{G_C}=\frac{\beta}{k}<\frac{1}{pd}+1$ is satisfied for $\delta<\bar{\delta}$ and we must have $\hat{R}>r$ in the region $\delta\in(0,\bar{\delta})$. The right hand side of Equation (50) is just $1+\frac{1}{\zeta-1}+\frac{\beta}{(\zeta-1)p(\hat{R}-r)L}$. Rewriting equation (50) as:

$$m(\frac{L}{N})>(\hat{R}-r)L\left[1+\frac{1}{\zeta-1}\right]+\frac{\beta}{p(\zeta-1)} \quad (51)$$

We note that if require $m(\frac{L}{N})>\frac{\beta}{p(\zeta-1)}$, the condition in equation (50) is true at $\bar{\delta}$ as $R(\bar{\delta})=r$. For $\delta<\bar{\delta}$, the interest rate $\hat{R}$ increases as $\delta$ decreases (see Proposition 3). Thus there exists $0\leq\underline{\delta}$ where this inequality holds for the region $[\underline{\delta},\bar{\delta})$. Hence if the discount factor $\delta$ is not too small, the condition in equation (50) holds.

Finally, every syndicate member has an incentive to play the equilibrium strategy since it satisfies the incentive condition, Equation (9), and results an a positive profit for the syndicate member. In contrast, deviating and not providing liquidity leads to zero profits for ever, this is lowest value attainable. Hence, the incentive condition, Equation (9), is necessary and sufficient, following a similar argument in Board (2011), that follows Abreu (1988).

■

**Proof of Proposition 3:**

To provide comparative statics, we rewrite Equation (42) as

$$pqm'(\phi)(\phi)^2 + \frac{1-\delta}{\delta}m'(\phi)(\phi)^2 = x \tag{52}$$

for $\phi = \frac{L}{N}$; thus only the ratio is identified. Clearly if $p^+ > p$, then $\phi = L/N$ must fall, hence the number of syndicate members must go up (since $L$ is fixed). A similar argument holds for $q^+ > q$. If $\delta^+ < \delta$, we must have that $\hat{\phi}^+ > \hat{\phi}$ which implies that for fixed $L$, $\hat{N}^+ > \hat{N}$.

If we have that $\delta \in [\bar{\delta}, 1]$, then $\frac{H_R(0)}{G_C} \geq \frac{1-(1-p)\delta}{p\delta}$ and $\hat{R} = r$, and the commitment fee is given by

$$C = pqm(\frac{L}{\hat{N}})L + \frac{1-\delta}{\delta}m(\frac{L}{\hat{N}})L + (\hat{N}-1)x \tag{53}$$

Differentiating with respect to $p$, and using the envelope theorem, we obtain (using Equation (52)) that:

$$\begin{aligned} \frac{dC}{dp} &= -\left[pqm'(\phi)(\phi)^2 + \frac{1-\delta}{\delta}m'(\phi)(\phi)^2 - x\right]\frac{\partial \hat{N}}{\partial p} + qm(\frac{L}{\hat{N}})L && (54)\\ &= qm(\frac{L}{\hat{N}})L && (55)\\ &> 0 && (56) \end{aligned}$$

which proves that commitment fees increase with $p$. A similar envelope result holds for an increase in $q$ or a decrease in $\delta$.

If $\frac{H_R(0)}{G_C} < 1 + \frac{1}{p\delta}$, we have $\hat{R} > r$. The right hand side of first order condition in Equation (46) is decreasing in $p$; hence an increase in $p$ must decrease $\hat{R}$ and $\hat{p}(R-r)L$. Using Equation (41) (and noting that the envelope theorem removes the effect through $\hat{N}$), we immediately obtain that $\hat{C}$ must go up in response to an increase in $p$. Similarly, using (46), $R$ does not depend on $q$, and then using Equation (41) and the envelope theorem, we obtain that $\hat{C}$ must go up in response to an increase in $q$.

Finally reducing $\delta$ when $\hat{R} > r$ is discussed in the proof of Proposition 2; if Conditions II stated in Proposition 2 hold, the $\hat{C}$ must go up in response to a reduction in $\delta$.

■

**Proof of Proposition 4:** The first order conditions for the maximization are:

$$\text{(w.r.t to R)}\quad H_R(p(R-r)L)pL - \lambda_m[1+pd]L_m - \lambda_n[1+pd]L_n - \mu = 0$$

$$\text{(w.r.t to } C_m\text{)}\quad G_C(C) - \lambda_m d - \gamma_m = 0 \tag{57}$$

$$\text{(w.r.t to } C_n\text{)}\quad G_C(C) - \lambda_n d - \gamma_n = 0 \tag{58}$$

$$\text{(w.r.t to } N\text{)}\quad -\lambda_n\left[1+d(pq)\right]n'(\frac{L_n}{N-1})\frac{L_n^2}{(N-1)^2} + \lambda_m dx = 0 \tag{59}$$

$$\begin{aligned}\text{(w.r.t to } L_n\text{)}\quad &\lambda_m\left[(R-r)(1+dp) - (1+dpq)(m(L_m)+m'(L_m)L_m)\right]\\ &-\lambda_n\left[(R-r)(1+dp) - (1+dpq)\left(n(\frac{L_n}{N-1}) + n'(\frac{L_n}{N-1})\frac{L_n}{N-1}\right)\right] = 0\end{aligned} \tag{60}$$

By Equations (57) and (58), if $C_m > 0$ and $C_N > 0$, we obtain $\lambda_m = \lambda_n$ and hence Equation (59) simplifies to

$$\left(\frac{1}{d} + pq\right) n'\left(\frac{L_n}{N-1}\right)\frac{(L_n)^2}{(N-1)^2} = x \tag{61}$$

which is identical to Equation (42); hence the size of each non-lead $\frac{L_n}{N-1}$ is still determined by the same equation. Further, by simplifying Equation (60) we obtain that

$$[m(L_m) + m'(L_m)L_m] = \left[n(\frac{L_n}{N-1}) + n'(\frac{L_n}{N-1})\frac{L_n}{N-1}\right] \tag{62}$$

We note that equation (44), $\frac{H_R(0)}{G_C} > \frac{1}{pd} + 1$ is independent of changes in $n(L)$. Hence in the region $[\bar{\delta}, 1]$, $\hat{R} = r$ and in the region $(0, \bar{\delta})$, $\hat{R} > r$: these regions are unaffected by changes in $n(L)$. In the region $(0, \bar{\delta})$ equation (46) still holds, i.e.,:

$$H_R(p(\hat{R}-r)L) = k(\frac{1}{pd} + 1) \tag{63}$$

and thus $p(\hat{R}-r)L$ is independent of $m(L)$ and $n(L)$. Conditions II changes slightly relative to Proposition (2) and now is:

$$\frac{m(L_m)L_m + n(\frac{L_n}{\hat{N}-1})L_n}{(\hat{R}-r)L} > 1 + \frac{H_R(p(\hat{R}-r)L)}{p(\hat{R}-r)LH_{RR}(p(\hat{R}-r)L)}. \tag{64}$$

Notice that the commitment for the lead is given by

$$C_m = \left(\frac{1}{d} + pq\right) m(L_m)L_m + (N-1)x - \left(\frac{1}{pd} + 1\right) p(R-r)L_m \tag{65}$$

and non-leads by

$$C_n = \left(\frac{1}{d} + pq\right) n(\frac{L_n}{N-1})L_n - \left(\frac{1}{pd} + 1\right) p(R-r)L_n \tag{66}$$

Adding equations (65) and (66), we obtain that

$$C = C_m + C_n = \left(\frac{1}{d} + pq\right) \left[m(L_m)L_m + n(\frac{L_n}{N-1})L_n\right] + (N-1)x - \left(\frac{1}{pd} + 1\right) p(R-r)L \tag{67}$$

Since $p(R-r)L$ does not change, the behavior of the total commitment fee depends on $[m(L_m)L_m + n(\frac{L_n}{N-1})L_n] + (N-1)x$. Suppose $n'_+(L) > n'(L)$ and $n''_+(L) > n''(L)$ for all $L$. We claim that

$$\begin{aligned} & C^+ > C \\ \iff \quad & \left(\frac{1}{d} + pq\right) \left[m(L_m^+)L_m^+ + n_+(\frac{L_n^+}{N^+-1})L_n^+\right] + (N^+-1)x - \left(\frac{1}{pd} + 1\right) p(R-r)L \\ > \quad & \left(\frac{1}{d} + pq\right) \left[m(L_m)L_m + n(\frac{L_n}{N-1})L_n\right] + (N-1)x - \left(\frac{1}{pd} + 1\right) p(R-r)L \end{aligned} \tag{68}$$

Assume not, then

$$\begin{aligned} & \left(\frac{1}{d} + pq\right) \left[m(L_m^+)L_m^+ + n(\frac{L_n^+}{N^+-1})L_n^+\right] + (N^+-1)x - \left(\frac{1}{pd} + 1\right) p(R-r)L \\ < \quad & \left(\frac{1}{d} + pq\right) \left[m(L_m^+)L_m^+ + n_+(\frac{L_n^+}{N^+-1})L_n^+\right] + (N^+-1)x - \left(\frac{1}{pd} + 1\right) p(R-r)L \\ \leq \quad & \left(\frac{1}{d} + pq\right) \left[m(L_m)L_m + n(\frac{L_n}{N-1})L_n\right] + (N-1)x - \left(\frac{1}{pd} + 1\right) p(R-r)L, \end{aligned} \tag{69}$$

where we use the fact that $n(\frac{L_n^+}{N^+-1}) < n_+(\frac{L_n^+}{N^+-1})$; this yields a contradiction to the optimality of the commitment fee $C$ (given the cost function $n(L)$) for the objective $H(p(R-r)L) + G(C)$ (given that $R$ is unchanged, this reduces to minimizing $C$).

Thus $C^+ > C$, $R^+ = R$, $TC^+ > TC$ and $\frac{C^+}{TC^+} > \frac{C}{TC}$.

Suppose $n'_+(L) > n'(L)$ and $n''_+(L) > n''(L)$ for all $L$.

Then from Equation (61), we obtain immediately that $\frac{L_n}{N-1}_+ < \frac{L_n}{N-1}$. If we further assume that $n(L) = L^\gamma$, we can rewrite Equation (61) as[39]

$$\left(\frac{1}{d} + pq\right) \gamma \left(\frac{L_n}{N-1}\right)^{\gamma-1} \left(\frac{L_n}{N-1}\right)^2 = x \tag{70}$$

and thus

$$\left(\frac{1}{d} + pq\right) n(L_n) = \left(\frac{1}{d} + pq\right) \left(\frac{L_n}{N-1}\right)^{\gamma} = \frac{x}{\gamma(L_n/(N-1))} \tag{71}$$

We can rewrite Equation (62) as:

$$[m(L_m) + m'(L_m)L_m] = (1+\gamma) \left(\frac{L_n}{N-1}\right)^{\gamma} = \frac{1+\gamma}{\gamma} \frac{1}{\frac{1}{d} + pq} \frac{x}{(L_n/(N-1))} \tag{72}$$

and clearly if $\gamma_+ > \gamma$, implies $(\frac{L}{N-1}_+)^{\gamma_+} > (\frac{L}{N-1})^{\gamma}$ (even though $\frac{L_n}{N-1}_+ < \frac{L_n}{N-1}$) ; then from Equation (72) we obtain that $L_m^+ > L_m$ and $\frac{L_m^+}{L} > \frac{L_m}{L}$.

To obtain further results on $C_m$ and $C_n$, we assume that $m(L) = L^\psi$, $\gamma > \psi > 1$, then Equation (72) simplifies to

$$(N-1)x = \left(\frac{1}{d} + pq\right) \frac{1+\psi}{1+\gamma} \gamma L_m^\psi L_n \tag{73}$$

Note that

$$\begin{aligned}
\frac{d(L_m^\psi L_n)}{d\gamma} &= \frac{d(L_m^\psi (L - L_m))}{d\gamma} \\
&= \psi L_m^{\psi-1} L - (1+\psi) L_m^\psi \\
&= L_m^{\psi-1}(\psi L_m + \psi L_n - \psi L_m - L_m) \\
&= L_m^{\psi-1}(\psi L_n - L_m);
\end{aligned}$$

hence if $\psi L_n > L_m$, using Equation (73) we obtain that $N$ increases in $\gamma$.

The commitment fee to the lead (using Equation (20) and also using Equation (73)) is given

[39] As we have previously noted in the discussion prior to Proposition 4, when we use the cost functions $m(L) = L^\psi$ and $n(L) = L^\gamma$, $\gamma > \psi > 1$, we need the additional restriction that $L_m \geq 1$ and $\frac{L_n}{N-1} \geq 1$, the minimum investment by any syndicate participant is one dollar.

by:

$$\begin{aligned} C_m &= \left(\frac{1}{d} + pq\right) m(L_m)L_m + (N-1)x - \left(\frac{1}{pd} + 1\right) p(R-r)L_m \\ &= \left(\frac{1}{d} + pq\right) \left[L_m^{\psi+1} + \frac{1+\psi}{1+\gamma}\gamma L_m^{\psi} L_n\right] - \left(\frac{1}{pd} + 1\right) p(R-r)L_m \end{aligned}$$

Dividing by $L_m$ we obtain that

$$\frac{C_m}{L_m} = \left(\frac{1}{d} + pq\right) \left[L_m^{\psi} + \frac{1+\psi}{1+\gamma}\gamma L_m^{\psi-1} L_n\right] - \left(\frac{1}{pd} + 1\right) p(R-r)$$

Since $R$ is not affected by changes in $\gamma$, we have that (using $L_n = L - L_m$)

$$\frac{\partial \frac{C_m}{L_m}}{\partial L_m} = \left(\frac{1}{d} + pq\right) L_m^{\psi-2} \left[\psi L_m + \frac{1+\psi}{1+\gamma}\gamma(\psi-1)L_n - \frac{\gamma}{1+\gamma}(1+\psi)L_m\right] > 0 \tag{74}$$

since $\frac{\psi}{1+\psi} > \frac{\gamma}{1+\gamma}$. Note that $C_m = \frac{C_m}{L_m} L_m$ and thus

$$\frac{\partial C_m}{\partial L_m} = \frac{\partial \frac{C_m}{L_m}}{\partial L_m} L_m + \frac{C_m}{L_m} > 0 \tag{75}$$

Hence

$$\frac{dC_m}{d\gamma} = \frac{\partial C_m}{\partial L_m}\frac{\partial L_m}{\partial \gamma} + \frac{\partial C_m}{\partial \gamma} > 0 \tag{76}$$

since all three terms in Equation (76) are positive.

■

**Proof of Corollary to Proposition 4:** As stated, the incentive constraints after the one time shock to non-lead syndicate costs is given by

$$\frac{\delta}{1-\delta}\frac{\Pi_{NL}^{+}}{(N-1)_{+}} \geq n\left(\left(\frac{L_n}{N-1}\right)_c\right)\left(\frac{L_n}{N-1}\right)_c - (R-r)\left(\frac{L_n}{N-1}\right)_c \tag{77}$$

$$\frac{\delta}{1-\delta}\Pi_L^{+} \geq m((L_m)_c)(L_m)_c - (R-r)(L_m)_c \tag{78}$$

where we have used the fact in Proposition 4 that $R$ does not change when the cost of liquidity provision of non-leads changes. Using that

$$\Pi_{NL}^{+} = (R-r)L_n^{+} + C_n^{+} - pqn\left(\left(\frac{L_n}{N-1}\right)_{+}\right)\left(\frac{L_n}{N-1}\right)_{+} \tag{79}$$

$$\Pi_L^{+} = (R-r)L_m^{+} + C_m^{+} - pqm(L_m^{+})L_m^{+} \tag{80}$$

Putting equations (78) and (79) together we obtain that

$$\frac{\delta}{1-\delta}\left[(R-r)L_n^+ + C_n^+ - pqn\left((\frac{L_n}{N-1})_+\right)(\frac{L_n}{N-1})_+\right] \geq n\left((\frac{L_n}{N-1})_c\right)(\frac{L_n}{N-1})_c - (R-r)(\frac{L_n}{N-1})_c \tag{81}$$

The function $n(L)L-(R-r)L$ has derivative $n'(L)L+n(L)-(R-r)$ and second derivative $n''(L)L+2n'(L)>0$ and thus is convex. The first derivative $n'(L)L+n(L)-(R-r)$ is initially negative at value $-(R-r)$ and eventually is zero for large enough $L^*$ and for $L>L^*$ this functon has positive derivative. Hence eventually the function $n'(L)L+n(L)-(R-r)$ is positive and increasing. Note that left hand side of equation (81) is positive since profits are positive. Hence there is a an unique $(\frac{L_n}{N-1})_c$ that solves equation (81) but $(\frac{L_n}{N-1})_+$ solves equation (81) and thus is the unique solution. Similarly we can argue that $L_m^+$ is the unique solution to equation (78). But then by Proposition 4 we know that when $\psi L_n < L_m$ we must have that $L_m^+ + (N-1)(\frac{L_n}{N-1})_+ < L$ and that $L_m^+ > L_m$, the result follows. ■

**Proof of Proposition 5:**

The maximization problem when the lead has an outside relationship with the firm that yields profits $\pi_o L_m$ is given by:

$$\min_{R,C,N,L_n} H(p(R-r)L)+G(C); \tag{82}$$

such that

$$(\lambda_m) - (1+pd)L_m(R-r) - d\left[C_m - pqm(L_m)L_m - (N-1)x\right] - d\pi_o L_m + m(L_m)L_m \leq 0; \tag{83}$$

$$(\lambda_n) - (1+pd)L_n(R-r) - d\left[C_n - pqn(\frac{L_n}{N-1})L_n\right] + n(\frac{L_n}{N-1})L_n \leq 0;$$

$$(\mu) - R \leq -r;$$

$$(\gamma_m) - C_m \leq 0;$$

$$(\gamma_n) - C_n \leq 0;$$

Equation (83), the incentive constraint for the lead, changes due to the presence of outside relationship with the firm that is lost if the credit line is withdrawn; thus there is an extra term related to $\pi_o L_m$, the per period profit from the outside relationship. The only first order condition that changes is the one with respect to $L_n$, Equation (60), which now becomes

$$\begin{aligned}\text{(w.r.t to } L_n) \qquad & \lambda_m \left[(R-r)(1+dp) - (1+dpq)(m(L_m) + m'(L_m)L_m)\right] + \lambda_m d\pi_o \\ & -\lambda_n \left[(R-r)(1+dp) - (1+dpq)\left(n(\tfrac{L_n}{N-1}) + n'(\tfrac{L_n}{N-1})\tfrac{L_n}{N-1}\right)\right] = 0; \end{aligned} \tag{84}$$

the first order condition with respect to $N$, Equation (59) remains the same, i.e.,

$$-\lambda_n \left[1 + d(pq)\right] n'(\frac{L_n}{N-1})\frac{L_n^2}{(N-1)^2} + \lambda_m dx = 0 \tag{85}$$

If $\gamma_m = \gamma_n = 0$, then we have $\lambda_m = \lambda_n$ and we can simplify Equation (84) to

$$[m(L_m) + m'(L_m)L_m] - \frac{1}{\frac{1}{d} + pq}\pi_o = \left[n(\frac{L_n}{N-1}) + n'(\frac{L_n}{N-1})\frac{L_n}{N-1}\right]. \tag{86}$$

This suggests the following solution. Initially for $L < \hat{L}$, $\gamma_n > 0$, $L_n = 0$, $L_m = L$ where $\hat{L}$ is determined by the equation

$$\left[m(\hat{L}) + m'(\hat{L})\hat{L}\right] - \frac{1}{\frac{1}{d} + pq}\pi_o = 0; \tag{87}$$

in this region where $L < \hat{L}$, we must have

$$[1 + dpq]m(L_m)L_m < [1 + dpq][m'(L_m)L_m + m(L_m)] < \pi_o d \tag{88}$$

which says that the incentive constraint Equation (83) does not bind; $\lambda_m = 0 < \lambda_n$. Hence the equation determining $L_n$ is given by

$$\lambda_n \left[1 + d(pq)\right] n'(\frac{L_n}{N-1})\frac{L_n^2}{(N-1)^2} = 0; \tag{89}$$

thus $L_n = 0$. Hence in this region, only the lead provides the credit line as the outside business relationship provides enough incentives.

However, when when $L > \hat{L}$, the incentive constraint for the lead Equation (83) binds and Equation (86) is relevant and the non-lead size is given by Equation (85) (remember $\lambda_m = \lambda_n$ again);

$$\left(\frac{1}{d} + pq\right) n'\left(\frac{L_n}{N-1}\right) \frac{(L_n)^2}{(N-1)^2} = x; \tag{90}$$

which is identical to the case where the lead has no outside business; hence the size of non-leads is fixed.

If $L < \hat{L}$, clearly $L_m = L$, the lead share goes up due to the outside business in the relationship. IF $L > \hat{L}$, Equation (86) implies a much higher $L_m$ for a given loan size $L$ and since the Equation (61) still determines $\frac{L_n}{N-1}$, the size of a single non-lead remains the same and $L_m$ goes up; similarly $\frac{L_m}{L}$ goes up. Hence, the number of non-leads must go down; $N-1$ drops.

The presence of an outside relationship does not change the equation determines $R$. Thus, equation (44), $\frac{H_R(0)}{G_C} < \frac{1}{pd} + 1$ is independent of presence of the outside profit. Hence in the region $[\bar{\delta}, 1]$, $\hat{R} = r$ and in the region $(0, \bar{\delta})$, $\hat{R} > r$ and $R$ is exactly same as before.

Fron this, we argue that $C_m^o + \pi_o L_m^o + C_n^o > C_m + C_n$ since $C_m + C_n$ in Proposition (4) is the lowest cost way of implementing the optimal second best credit line arrangement given the interest rate $R$. Thus:

$$\begin{aligned}
& C_m^o + \pi_o L_m^o + C_n^o \\
= & \left[\frac{1}{d} + pq\right] m({}^oL_m) L_m^o + (N^o - 1)x + \left[\frac{1}{d} + pq\right] n\left(\frac{L_n^o}{N^o - 1}\right) L_n^o - \left(\frac{1}{pd} + 1\right) p(R - r)L, \\
< & \left(\frac{1}{d} + pq\right)\left[m(L_m)L_m + n(\frac{L_n}{N-1})L_n\right] + (N-1)x - \left(\frac{1}{pd} + 1\right) p(R-r)L \\
= & C_m + C_n
\end{aligned}$$

where the strict inequality occurs because liquidity risk sharing is inefficient. Thus the distortion caused by outside relationship leads to a higher overall costs for the firm but some part of this $(\pi_o L_m)$ is sunk.

To show that $C_m^o + C_n^o < C_m + C_n$ we use the envelope theorem.

$$C_m^o + C_n^o = \left[\frac{1}{d} + pq\right] m(L_m)L_m + (N-1)x - \pi_o L_m + \left[\frac{1}{d} + pq\right] n\left(\frac{L_n}{N-1}\right) L_n - \left(\frac{1}{pd} + 1\right) p(R-r)L$$

It is clear that

$$\frac{d[C_m^o + C_n^o]}{d\pi_o} = -L_m + \frac{\partial [C_m^o + C_n^o]}{\partial L_m} + \frac{\partial [C_m^o + C_n^o]}{\partial N} < 0 \tag{91}$$

since by the envelope theorem, the last two terms are zero. Confirming this;

$$\frac{\partial [C_m^o + C_n^o]}{\partial N} = -\left[\frac{1}{d} + pq\right] n'(\frac{L_n}{N-1}) \frac{L_n^2}{(N-1)^2} + x = 0 \tag{92}$$

(which follows from Equation (85)); and

$$\frac{\partial[C_m^o + C_n^o]}{\partial L_m} = [\frac{1}{d} + pq]\,(m(L_m) + m'(L_m)L_m) - \pi_o - [\frac{1}{d} + pq]\left(n(\frac{L_n}{N-1}) + n'(\frac{L_n}{N-1})\frac{L_n}{N-1}\right) = 0 \quad (93)$$

(which follows from Equation (86)). Hence $\frac{d[C_m^o + C_n^o]}{d\pi_o} < 0$; an increase in outside business reduces the direct commitment fee to the syndicate.

Further we argue that $C_m^o + \pi_o L_m^o > C_m$. To see this note that:

$$\begin{aligned}
& C_n^o \\
= \; & \left[\frac{1}{d} + pq\right] n\left(\frac{L_n^o}{N^o - 1}\right) L_n^o - \left(\frac{1}{pd} + 1\right) p(R - r) L_n^o \\
= \; & \left\{\left[\frac{1}{d} + pq\right] n\left(\frac{L_n^o}{N^o - 1}\right) - \left(\frac{1}{pd} + 1\right) p(R - r)\right\} L_n^o \\
= \; & \left\{\left[\frac{1}{d} + pq\right] n\left(\frac{L_n}{N - 1}\right) - \left(\frac{1}{pd} + 1\right) p(R - r)\right\} L_n^o \\
< \; & \left\{\left[\frac{1}{d} + pq\right] n\left(\frac{L_n}{N - 1}\right) - \left(\frac{1}{pd} + 1\right) p(R - r)\right\} L_n \\
= \; & C_n
\end{aligned}$$

where we have used that $L_n^o < L_n$, $\frac{L_n^o}{N^o-1} = \frac{L_n}{N-1}$ and that $C_n > 0$; the last implies that $\left[\frac{1}{d} + pq\right] n\left(\frac{L_n}{N-1}\right) - \left(\frac{1}{pd} + 1\right) p(R - r) > 0$.

Since $C_m^o + \pi_o L_m^o + C_n^o > C_m + C_n$ and $C_n^o < C_n$, one immediately obtains that $C_m^o + \pi_o L_m^o > C_m$. Further, it is clear that

$$\frac{C_m^o + \pi_o L_m^o}{C_n^o} > \frac{C_m}{C_n}, \quad (94)$$

and that $\frac{\Pi_L^o}{\Pi_{NL}^o} > \frac{\Pi_L}{\Pi_{NL}}$, the lead makes more overall and relative profits when there is outside business for the lead.

■

**Proof of Corollary to Proposition 5:**

From equation (86), we obtain that

$$[m(L_m^o) + m'(L_m^o)L_m] - \frac{1}{\frac{1}{d} + pq}\pi_o = \left[n(\frac{L_n}{N-1}, \gamma) + n'(\frac{L_n}{N-1}, \gamma)\frac{L_n}{N-1}\right].$$

where we have used the fact that the right hand side does not depend on the outside business parameter $\pi$ since $\frac{L_n}{N-1}$ does not (we are in the interior solution). Then $\frac{dRHS}{d\gamma}$ is positive and does depend on the outside business parameter $\pi$, hence $\frac{dLHS}{d\gamma}$ is positive and does not depend on the outside business parameter $\pi$. Then

$$
\begin{aligned}
& \frac{dLHS}{d\gamma} \\
= \quad & [2m'(L_m^o) + m''(L_m^o)L_m^o)^2]\frac{dL_m^o}{d\gamma} \\
= \quad & [2m'(L_m) + m''(L_m)L_m^2)]\frac{dL_m}{d\gamma}
\end{aligned}
$$

and since $L_m^o > L_m$ and $m'(\cdot)$ and $m''(\cdot)$ increase in $L_m$, we must have $\frac{dL_m^o}{d\gamma} < \frac{dL_m}{d\gamma}$. ■

## A-2 Additional Results

### A-2.1 Pricing of credit lines during recessions

As we discuss in Subsection 4.3 Proposition 4 posits that when lead banks experience a negative shock they will charge not only higher fees but also higher credit spreads to grant credit lines. We investigate this hypothesis here proxying negative shocks with recession periods. Specifically, we use the following pricing model:

$$
\begin{aligned}
PRICE_{c,f,b,t} = \alpha_0 + \alpha_l RECESSION_t + \\
\beta_1 LOAN_{c,t} + \beta_2 BORROWER_{f,t-1} + \beta_3 BANK_{b,t-1} + \epsilon_{c,f,b,t}
\end{aligned}
\tag{95}
$$

where $PRICE_{c,f,b,t}$ is either the undrawn fee or the all-in-drawn spread on credit line $c$ of firm $f$ from bank $b$ at issue date $t$. The key variable of interest in that specification is $RECESSION$, a dummy variable equal to 1 for if the credit line was taken out during one of the three NBER recessions during our sample period (1990/91, 2001, and 2008/09).[40] We investigate the impact of recessions on banks' pricing of credit lines controlling for the same set of borrower-, loan- and lead bank-specific factors we use in Subsection 4.3.1. We do not control for the market conditions or time fixed effects now because we want to identify the effect of recessions on credit lines' prices.

The results of this investigation are reported in Table A-3.1 below. Columns (1)-(3) report results for the undrawn fee. Columns (4)-(6) report results for the all-in-drawn spread. In each panel, Column (1) reports results from pooled analysis; Column (2) report results estimated with borrower fixed effects; and Column (3) report results estimated with bank-borrower fixed effects.

According to Columns (1)-(3), undrawn fees of credit lines taken out during recessions are on average 2 to 3 bps higher (about 12% of the sample mean (26 bps)). According to Columns (4)-(6), all-in-drawn spreads of credit lines taken out during recessions are on average 6 to 7 bps higher (about 5% of the sample mean (155 bps)). Both of these results are driven by the 2008/09 recession. During this recession, undrawn fees went up by 6 bps (21% of the mean) while all-in-drawn spreads increased by 15 to 25 bps (10 to 16% of the mean).

Our pricing results suggest that the effect of bank supply shocks are present in recessions and was quite large in the 2008-2009 recession. Consistent with Proposition 4, our results show that during

[40]Given we have information on the origination date of each credit date, we use information from NBER's peak and trough dates to identify the beginning and the end of each recession.

recessions there is an increase in the cost of credit lines as captured by their fees and credit spreads.

Table A-3.1 Cost of credit lines over the business cycle[a]

| | Panel A: Undrawn fees | | | Panel B: All-in-drawn spreads | | |
|---|---|---|---|---|---|---|
| Variables | 1 | 2 | 3 | 4 | 5 | 6 |
| RECESSION | 2.629*** | 2.304*** | 2.055*** | 7.497** | 6.391** | 7.468*** |
| | (3.63) | (3.48) | (3.03) | (2.16) | (2.29) | (2.91) |
| constant | 15.921** | 2.616 | -31.414*** | 10.272 | -39.364 | -303.974*** |
| | (2.40) | (0.29) | (-3.38) | (0.16) | (-1.47) | (-4.63) |
| Observations | 29583 | 29538 | 24644 | 32826 | 31334 | 27477 |
| R-squared | 0.564 | 0.576 | 0.791 | 0.562 | 0.736 | 0.795 |
| Borrower FE | NO | YES | NO | NO | NO | YES |
| Bank-borrower FE | NO | NO | YES | NO | NO | YES |

[a] Dependent variable in Panel A is the undrawn fee borrowers pay when they take out a credit line. Dependent variable in Panel B is the All-in-drawn spread over Libor that borrowers pay on the funds they drawdown on their credit lines. $RECESSION$ is a dummy variable equal to one for the three recessions as classified by NBER during our sample period (1987-2020). All of the models include the sets of borrower-, loan-, and bank-specific factors reported in Table 1 as well as dummy variables to account for the borrower activity as defined by 1-digit SIC codes. Models estimated with robust standard errors clustered by borrower and by bank. We report t statistics in parentheses. *** denotes 1% significant level, ** denotes 5% significant level, and * denotes 10% significant level.
Source: Dealscan