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BANKS' ADVANTAGE IN HEDGING LIQUIDITY RISK: THEORY AND EVIDENCE FROM THE COMMERCIAL PAPER MARKET

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Abstract

This paper argues that banks have a unique ability to hedge against systematic liquidity shocks. Deposit inflows provide a natural hedge for loan demand shocks that follow declines in market liquidity. Consequently, one dimension of bank "specialness" is that banks can insure firms against systematic declines in market liquidity at lower cost than other financial institutions. We provide supporting empirical evidence from the commercial paper (CP) market. When market liquidity dries up and CP rates rise, banks experience funding inflows, allowing them to meet increased loan demand from borrowers drawing funds from pre-existing commercial paper backup lines *without* running down their holding of liquid assets. Moreover, the supply of cheap funds is sufficiently large so that pricing on new lines of credit actually *falls* as market spreads widen.

I. INTRODUCTION

The rise of the commercial paper market, which began in the 1970s, followed by the growth of the junk bond market in the 1980s and 1990s, has seemingly reduced the role of banks in providing credit to large businesses (Mishkin and Strahan, 1998). This much-remarked-upon evolution away from banks and toward the securities markets, though, has not rendered banks irrelevant (Boyd and Gertler, 1994). While they do provide less credit than before, banks remain important, even for large firms, as the "liquidity provider of last resort." This liquidity insurance role is notable in the commercial paper market, where issuers invariably secure a backup line of credit from their bank as protection against market pullbacks. Why do commercial banks, as opposed to some other kind of financial institutions, provide this liquidity insurance? In this paper, we argue that banks can provide firms insurance against *market-wide* liquidity shocks at lower cost than other financial intermediaries because deposit inflows provide a natural hedge for loan demand shocks.

Banks have traditionally provided liquidity insurance in the form of loan commitments to many classes of borrowers. In the case of the commercial paper backup lines, these contracts allow firms to borrow (or "take down") up to a pre-determined amount of funds at a fixed spread over a safe market benchmark interest rate such as LIBOR. This liquidity insurance softens the blow of reduced liquidity, where liquidity can be defined as the firm's ability to access the capital markets at attractive (fair) prices.[1] Banks' function to insure liquidity has grown in importance with the development of the capital markets over the past three decades. Because banks are viewed as a safe haven by investors, funding tends to become more available to them during

[1]According to this definition, a decline of liquidity is caused by an increase in arm's length investors' perceived opaqueness of firms.

periods of market stress, just when borrowers want to draw funds from their loan commitments. Hence, the funding flows within a bank complement each other, with deposit inflows serving as a natural hedge for outflows from loan commitment take-downs. The hedge is natural because the bank does not have to induce it or pay for it: the inflow of deposit funds that helps to make the new loans fungible is the same as the outflow from the capital markets. Because of this hedge, banks can offer the lowest-cost insurance against a *systematic* shock to liquidity. The banks' ability to sell liquidity insurance more cheaply than other financial institutions provides an explanation for the viability of their business in this particular market.

Our argument complements Kashyap, Rajan and Stein (2002), who propose a simple and convincing risk-management rationale for a defining characteristic of a commercial bank, namely a financial intermediary that combines demand deposits with loan commitments and lines of credit (we use these two terms synonymously).[2] In effect, banks offer liquidity to both households and firms with these two products. Risk management dictates that as long as the demand for liquidity from depositors and borrowers is not too highly correlated, the intermediary should pool these two classes of customers together to conserve on its need to hold costly liquid assets – the buffer against unexpected deposit withdrawals and loan take downs.[3] Our argument extends the KRS rationale because we highlight an additional specialty of banks – their unique ability to hedge against systematic liquidity shocks. As a result, banks can insure against *market-wide* declines in

[2]Some early studies analyzed loan commitments as a hedge against changes in interest rates or credit quality (see, for example Thakor (1982) and Kanatas (1987)), and others analyzed the pricing structure of loan commitments as a way to separate high-quality from low-quality borrowers (see, for example, Boot, Thakor and Udell (1987) and Thakor and Udell (1987)). Other studies have emphasized loan commitments as protection for borrowers against credit rationing by their bank (see, for example, Berger and Udell (1992) and Morgan (1998)). For more recent studies on pricing of loan commitments as options (see Shockley and Thakor (1997) and Chava (2002)).

[3]Holding liquid assets is costly because these assets earn low returns and create additional agency problems for the financial institution (Myers and Rajan, 1998).

the availability of market liquidity at lower cost than other institutions. While the KRS risk-management argument is quite general, it applies to any firm that can diversify efficiently across different lines of business. Our contribution is to add a new dimension of bank "specialness" that has not been emphasized in the literature.[4]

Section II below provides some background by describing banks' liquidity insurance role in the commercial paper market. The main argument is presented Section III, where a simple model shows how the correlation between a lender's funding cost and the availability of market liquidity affects its ability to price this insurance. In a competitive equilibrium, the price of loan commitments varies *negatively* with the covariance between the availability of funding to the lender and the availability of market liquidity. This is the main testable implication of the model.

In Sections IV and V, we show that bank funding supply does, in fact, increase when market liquidity becomes scarce, where liquidity is measured by the difference between the commercial paper rate to high-grade borrowers and the Treasury Bill rate (the "paper-bill spread"). We provide three pieces of supporting evidence. First, we show that bank asset growth increases in response to widening of spreads in the commercial paper market, controlling for the overall level of interest rates. Moreover, the increase in assets occurs not only in the loan and C&I loan portfolio, but also among banks' holdings of *liquid* assets (cash and securities). Thus, rather than running down their buffer of liquid assets in response to market shocks, as banks would do in the

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[4]Previous research has identified several dimensions of bank specialness, each emphasizing a link or synergy between the liability (deposits) and asset (illiquid loans) sides of the business. For example, Fama (1985) suggested that information stemming from the business checking account could give banks an advantage in lending over other financial intermediaries; for recent empirical evidence, see Mester, Nakamura and Renault (2002). Mester and Berlin (1999) argue that banks' access to inelastically supplied funds (core deposits) allows them to offer borrowers insurance against changes in interest rates. Other studies suggest that because bank loans are illiquid, and thus make "bad" collateral against which to borrow, the optimal capital structure is one characterized by very liquid (or short-term) liabilities that subject the bank to the possibility of a run (e.g. Calomiris and Kahn, 1991, Flannery, 1994, and Diamond and Rajan, 2001). And, as noted above, KRS and our study emphasize a scope economy between bank funding and bank lending related to their role as liquidity providers.

face of unexpected increases in loan demand alone, bank increase their holding of liquid assets. This increase in liquid assets is strong evidence of greater availability of funding to banks. Second, we show that the quantity of assets funded with deposits, particularly large time deposits, increases with the paper-bill spread, reflecting the increased availability of deposit finance during periods of high spreads. Third, and perhaps most important, we compare how the funding costs of banks versus finance companies changes with the commercial paper spread. We find that yields on bank-issued paper (i.e., large negotiable CDs) *decreases* with the commercial paper spread, whereas the yields on finance-company-issued paper do not change. This differential response to commercial paper shocks is our most direct evidence that banks have a comparative advantage over their closest competitor in offering liquidity insurance.

In our last set of results, we estimate how the price of *new* commercial paper backup lines of credit vary with changes in the price of market-provided liquidity, again as measured by the paper-bill spread. Consistent with our findings on banking funding, we show that the price of the new lines *decreases* with the paper-bill spread. Thus, when credit markets tighten, the increased availability of funding to banks seems to be large enough to allow banks to fund their obligations under existing lines of credit *and* to issue new lines at low prices.

II. BANKS' INSURING LIQUIDITY IN THE COMMERCIAL PAPER MARKET

Under normal circumstances, commercial paper offers the lowest cost source of short-term financing for large, well-established firms. The commercial paper backup line of credit, however, allows a firm to borrow from its bank at a pre-determined spread, thus providing insurance against the possibility of having to borrow when commercial paper is expensive (e.g. because outstanding paper is maturing). Borrowing in the commercial paper market may be expensive either because a firm's credit quality has declined, or because the overall supply of liquidity has declined.[5] Firms pay their bank an annual fee for this insurance.

Banks' functioning as liquidity insurance providers originated early in the development of the commercial paper market. In 1970, Penn Central Transportation Company filed for bankruptcy with more than $80 million in commercial paper outstanding. As a result of their default, investors lost confidence in *other* large commercial paper issuers, making it difficult for some of these firms to refinance their paper as it matured. In response to this difficulty, commercial paper issuers began purchasing backup lines of credit from banks to insure against future funding disruptions (Saidenberg and Strahan, 1999).

These market shocks have happened periodically since the Penn Central debacle. Typically, some event in the markets hampers investor confidence in their ability to sort out high-quality from low-quality firms. During the recent Enron crisis, for example, the accuracy of financial statements came into question and, as a result, many firms faced difficulty borrowing in the commercial paper market. In March of 2002, the *Wall Street Journal* reported the following: "For years, the commercial-paper market has served as the corporate world's automated teller machine, spitting out a seemingly endless supply of cash for businesses at super-low interest rates... But now, amid financial jitters caused by Enron Corp.'s collapse, that machine is sputtering, sending a surprising number of companies of all sizes scrambling to find money for their most basic needs, from paying salaries to buying office supplies. Some are paying higher interest rates so they can keep selling paper. But others, after getting the cold shoulder from

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[5]Banks protect themselves from large declines in credit quality with the "material adverse change" covenant. This covenant allows a bank to get out of its obligations to provide funds to a borrower that has experienced a significant downgrade. Banks, however, generally avoid invoking this covenant to protect their reputation in this market.

commercial-paper investors, have turned to raising debt by other, costlier, means... Like running water, it's (commercial paper) only missed when it stops flowing. The market first began experiencing difficulties about a year ago, as the economy slowed. Enron's collapse fueled more worry -- in part because it caused credit-rating agencies to become more hawkish. Stung by criticism that both Moody's and Standard & Poor's kept Enron at investment grade until just five days before it filed for bankruptcy last fall, the rating agencies started poring over balance sheets, looking for companies that seem over-dependent on commercial paper."[6]

Before Enron, the Russian default in late summer of 1998 followed by the failure of the hedge fund Long-Term Capital Management (LTCM) created a similar increase in uncertainty, leading to a so-called "flight to quality." During these episodes, investor funds flow toward safe investments such as bank deposits (and government securities), rather than to risky investments such as commercial paper, corporate bonds or equities. As we show below, banks experience inflows of funds during these periods, and, at the same time, firms have a high demand to take down funds from pre-existing lines of credit. Said in a slightly different way, when market liquidity dries up, the *supply* of bank loans increases (because funding flows into banks) at the same time that *demand* for bank loans increases (because firms want to take down funds). Re-intermediation occurs during periods of market turmoil because investors trust banks, perhaps because banks are explicitly and implicitly insured by the government or because banks have the information to sort out high-quality and low-quality firms. In short, when investments are perceived as opaque, firms have to finance indirectly through the banks.

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[6]See "Cash Drought: A Dwindling Supply of Short-Term Credit Plagues Corporations-Market in Commercial Paper hurt by Enron Fears," Gregory Zuckerman, *Wall Street Journal*, March 28, 2002.

III. A MODEL OF LOAN-COMMITMENT PRICING

Our goal is to construct a simple asset-pricing model of loan commitments that uses our "natural hedge" hypothesis to highlight the main thesis of this paper: an intermediary whose funding cost declines when market liquidity becomes scarce has a comparative advantage over competing intermediaries in issuing this product. We then offer supporting evidence that banks, the dominate intermediary in this market, have access to funding that exhibits this property.

Assume for simplicity that market liquidity is the only systematic risk factor.[7] The present value of a 1-period loan with $1 commitment, *P*, is determined according to a general asset-pricing model of the form:

$$P_{LC} = \frac{1}{1+r}\left(E[r_{LC}] - \gamma Cov[r_{LC}, L] \right)$$

where L is the liquidity risk factor, i.e. the credit market, and γ is the equilibrium price of L-risk, and r is the riskless rate.

The realized return on a loan commitment, r_{LC}, is random and has two components. The first is a fixed return, r_{UD}, which is derived from the pre-paid fee on undrawn funds. The risky part of the return can itself be decomposed into two further parts, the return on the drawn funds (r_L) and the cost to the intermediary of funding the loan, i.e. the *yield* on deposits, (r_D). The return on the loan is risky because of the possibility of default; the cost of funding the loan is risky because it

[7] Other risk factors can be added to the model without changing the basic story, although they would not contribute to banks' comparative advantage in commitment lending. To the extent that a decline in market liquidity captures a systematic widening of spreads, the latter can be due to any number of underlying factors. In effect we can interpret a priced systematic liquidity factor as the catch-all factor that aggregates a number of underlying systematic factors, i.e as the projection of the stochastic discount factor on the commercial paper market.

varies systematically with the availability of liquidity in the market (*L*). Moreover, the fraction of funds taken down, denoted as α, also is a random variable with values between 0 and 1. We can write the return on the loan commitment as follows:

$$r_{LC} = (1-\alpha)\, r_{UD} + \alpha\,(\, r_L - r_D\,)$$

To simplify the exposition, we will assume that the take down rate, α, is a decreasing deterministic function of L. In words, when liquidity is plentiful (L is high), the take down rate is low because borrowers use the commercial paper markets, and when liquidity is scarce, the take down rate is high because commercial paper borrowing is expensive. We can decompose the systematic risk associated with a loan commitment into three parts, as follows:

$$Cov[r_{LC},L] = Cov[(1-\alpha)r_{UD},L] + Cov(\alpha r_L,L) - Cov[\alpha r_D,L]$$

The first two covariance terms depend *only* on the actions taken by the borrower – that is, the sensitivity of the borrower's take down behavior to liquidity (α) and the return on the loan conditional on funds being drawn (r_L). Thus, the magnitude of these two terms are *independent* of the type of intermediary that has sold the loan commitment. The third term, however, depends on how the intermediary's funding costs (r_D) varies with L. Analytically, we are interested in the sign of the following expression:

$$\frac{dCov[\alpha r_D,L]}{dCov[r_D,L]}$$

We assumed above that the takedown fraction is a deterministic function of the liquidity shock; we also assume that the joint distribution of r_D and L is normal:[8]

$$(r_D, L) \sim N(\,(\overline{r_D}, 0)\,,\ \Sigma\,)$$
$$Cov(r_D, L) = \sigma_{r_D, L}$$

Now, using the normality of L we can write (see the Appendix)

$$Cov(\alpha r_D,\ L) = \frac{\sigma_{r_D L}}{\sigma_L^2} E[\alpha(L)L^2] + E[r_D]E[\alpha(L)L]$$

Notice that this is a linear function of $\sigma_{r_D L}$, with a negative intercept (because α is decreasing and E[*L*]=0). The key result is that the slope is positive:

$$\frac{dCov(\alpha r_D, L)}{d\sigma_{r_D L}} = \frac{E[\alpha(L)L^2]}{\sigma_L^2} > 0$$

because the integrand in the expectation is non-negative (because $0 \leq \alpha \leq 1$). If the market for loan commitment is competitive, profits are eliminated (i.e P=0), so that we have:

$$E[r_{LC}] = \gamma\ [\ A - Cov[\alpha r_D, L]\ ]$$
$$A = Cov[(1-\alpha) r_{UD}, L] + Cov(\alpha r_L, L)$$

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[8]This assumption is made for tractability, since we are concerned with the first two moments. The argument is general and can be applied using the second-order approximation of any distribution where the moments exist.

and finally, we get the main result:

Proposition 1: The expected return *decreases* with an increasing covariance between funding costs and liquidity:

$$\frac{dE[r_{LC}]}{d\sigma_{r_D L}} = - \gamma \frac{dCov[\alpha r_D, L]}{d\sigma_{r_D L}} < 0$$

Proposition 1 implies that *only* an intermediary with a high covariance between its funding cost and the availability of market liquidity (call it a "bank" for the moment) will be able to offer this product in equilibrium. Other intermediaries offering the product at prevailing prices would find the business unprofitable (negative NPV). Because these "non-bank" intermediaries experience more systematic risk when offering loan commitments, they would implicitly discount the expected returns at a higher rate than "banks."

A finance company such as GE Capital is a real-world example of a "non-bank" intermediary. These intermediaries offer some similarities to banks on the asset side of their business because they lend (and lease) to borrowers with information problems. In fact, Carey, Post and Sharpe (1998) find *no difference* in measures of opacity for finance company borrowers and bank borrowers, so they seem to solve the same kinds of information problems as banks. Most lines of credit, however, are issued by commercial banks rather than finance companies (Kashyap, Rajan and Stein, 2002). This difference makes sense in the context of our model because finance company liabilities are composed mainly of commercial paper and bonds, thus their funding costs would tend to covary negatively with the availability of market liquidity, just the opposite of our theoretical "bank." In the next section, we will show that funding costs of real-world banks covary positively with market liquidity (i.e. $\sigma_{RD,L} > 0$), whereas funding costs to finance companies do not.

By making one additional simplifying assumption, we can derive some cross-sectional implications from our model. Consider functions $\alpha(L)$ that are twice-differentiable such that

$$E[\alpha''(L)] \geq 0$$

Intuitively, since α is non-increasing, the first derivative is always non-positive, and since higher values for $-\alpha'$ correspond to faster change in α, writing the condition as $E[(-\alpha'(L))'] \leq 0$ shows that the faster increase in draw-downs occurs, on average, for negative shocks L. In this way, the assumption rules out pathological cases but includes the desirable functional forms for α.
Now, using the normality of L we can write (see the Appendix):

$$Cov(\alpha r_D, L) = (E[\alpha''(L)]\sigma_L^2 + E[\alpha(L)])\sigma_{r_D L} + E[r_D]E[\alpha(L)L]$$

The positive slope is

$$\frac{dCov[\alpha r_D, L]}{d\sigma_{r_D L}} = E[\alpha''(L)]\sigma_L^2 + E[\alpha(L)] > 0$$

The last equation shows how the sensitivity of the loan commitment expected return to the covariance between the funding cost and the liquidity shocks depends on the particulars of borrower behavior, i.e. on the exact functional form for α. We can illustrate this through some simple examples. First, we consider a constant function α.

Case A: Constant withdrawals: $\alpha(L)=\alpha_0=E(\alpha)$.

This function corresponds to the case of low-quality borrowers who draw their lines idiosyncratically (say, in response to a downgrade), regardless of the state of the economy (i.e. regardless of liquidity). In this case, we have

$$(1) \qquad \frac{dE[r_{LC}]}{d\sigma_{r_D L}} = -\gamma\ \alpha_0$$

Note that the intermediary with access to cheap funding still has a competitive advantage, which depends on both the price of liquidity risk and the expected frequency of loan takedowns.

Case B: Linear withdrawals: $\alpha(L) = (L_{hi} - L)/(L_{hi} - L_{low})$ *for* $L_{low} \leq L \leq L_{hi} < 0$

For this example, we assume that the commitments are always drawn ($\alpha = 1$) under a certain threshold level for the shock ($L < L_{low}$), corresponding to the notion of "big" liquidity shocks, and always remain undrawn ($\alpha = 0$) if the shock L is *above* a certain threshold level, $L > L_{hi} > L_{low}$ (e.g. if the credit market is "good"). This simplification includes "natural" functional forms for α, like gradual transition functions of the form:

$$[(L_{hi} - L)/(L_{hi} - L_{low})]^{a}\ ,\ 0 < a < 1 \text{, for } L_{low} \leq L \leq L_{hi} < 0.$$

When a=1, the function becomes truncated linear, and we can also model a step function as the limiting case where $L_{low} \rightarrow L_h$. Since this function is not differentiable at L_{hi} and L_{low}, we will show that the derivative is positive. We have (see the Appendix)

$$\frac{dE[r_{LC}]}{d\sigma_{r_D L}} = -\frac{\gamma\sigma_L}{L_{hi} - L_{lo}}\left[\frac{L_{hi}}{\sigma_L}\Phi\left(\frac{L_{hi}}{\sigma_L}\right) - \frac{L_{lo}}{\sigma_L}\Phi\left(\frac{L_{lo}}{\sigma_L}\right) + 2\left(\phi\left(\frac{L_{hi}}{\sigma_L}\right) - \phi\left(\frac{L_{lo}}{\sigma_L}\right)\right)\right]$$

Where Φ and ϕ are the normal cumulative distribution and density functions, respectively. At the limit $L_{low} \rightarrow L_h$, α becomes the step function $\chi_{[-\infty, Lhi]}$, and in that case

$$\frac{dE[r_{LC}]}{d\sigma_{r_D L}} = -\gamma \left[\Phi\left(\frac{L_{hi}}{\sigma_L}\right) - \frac{L_{hi}}{\sigma_L}\phi\left(\frac{L_{hi}}{\sigma_L}\right) \right]$$

which can also be written as follows:

(2) $$\frac{dE[r_{LC}]}{d\sigma_{r_D L}} = -\gamma \left[\alpha_0 \left(1 - \frac{L_{hi}}{\sigma_L}\right)\right]$$

Now, we can compare how the strength of the bank's natural funding hedge varies across two different sorts of borrowers: idiosyncratic borrowers and systematic borrowers. Idiosyncratic borrowers are those borrowers whose take-down behavior does not depend on liquidity (Case A); for example, high-risk borrowers whose behavior will depend mainly on changes in their own credit quality rather than on market conditions. Systematic borrowers, in contrast, are firms whose take-down behavior is predicated on the availability of market liquidity (Case B); for example, highly rated firms that would only draw funds in response to shocks to the supply of liquidity in the commercial paper market as a whole. If we consider two borrowers with the same expected takedown behavior (i.e. the same $E(\alpha)=\alpha_0$), then equations (1) and (2) show that the borrower whose behavior is systematically related to market liquidity benefits more from access to bank-issued lines of credit, relative to the idiosyncratic borrower (assuming the these two borrowers draw on their lines with probability less than ½; or, in the case of the idiosyncratic borrower, $L_{hi} < 0$). Thus, banks, with their natural funding hedge, would be even more likely to dominate the market for lines of credit to high-grade firms whose take down behavior is dominated by the systematic *L*-factor. In contrast, other financial institutions without access to bank-style funding (i.e. funding that flows in during periods of tight markets) might be better able to compete for lower-grade borrowers whose take down behavior depends more on idiosyncratic credit shocks.

This cross-sectional implication of our model may help explain the empirical findings of Carey et al (1998), who show that finance company borrowers are riskier than bank borrowers in observable ways (they have higher leverage), but not in ways suggesting that either banks or finance companies possess a comparative advantage in solving information problems. According to our model, they key difference has to do with liquidity risk. Banks have an especially large advantage among the class of borrowers where the main risk of making a loan commitment comes from liquidity risk – the risk of having to fund the loan when market spreads are high – rather than default risk. When take down behavior tends to be idiosyncratic, reflecting largely changes in a high-risk borrower's credit quality, the main risk of making a loan commitment stems from default; the liquidity advantage of banks for these borrower is less pronounced, thus helping to explain why finance companies tend to lend more to this kind of firm.

IV. Empirical Evidence: Banks' Funding Advantage in offering Backup Lines

In this section, we test how the banking system responds to increases in the price of market-provided liquidity. We report aggregate time series evidence that bank assets grow faster when the paper-bill spread is high than when it is low. This increased growth occurs not only in lending, but in banks' holdings of cash and securities as well. The across-the-board increases in asset growth suggest that as demand for bank loans increases (in response to higher cost of borrowing in markets), so does the supply of funding (hence liquid assets rise rather than fall). We then look at the other side of the balance sheet, testing how banks' fund their increase in growth. We find deposits overall, as well as large time deposits, grow faster as the paper-bill spread widens; other aspects of bank funding, however, do not grow faster when spreads widen. Third, we show that yields on large time deposits (relative to Treasury rates) decrease with the spread, suggesting better funding availability to banks, whereas yields on finance company paper does not change significantly.

Methods and Data

The difficulty empirically with our tests is that shocks in the commercial paper market have historically been dramatic but brief. In Section II, we described instances in which commercial paper availability declined in response to market turmoil, such as the Penn Central default in the early 1970s. These spikes have occurred periodically over the past 25 years.

Chart 1 plots the paper-bill spread during our sample period, from 1988 to 2000. As the chart shows, the spikes in the spread tend to be dramatic but short lived. For example, at the beginning of the U.S. air attack against Iraq in the middle of January of 1991, commercial paper spreads shot up above 100 basis points very briefly. Later, in the last week of September 1998, the Federal Reserve unexpectedly reduced its target for the Fed Funds rate in response to the LTCM debacle and rising concern of contagion. In response, commercial paper spreads rose from 68 basis points to 118 basis points in just two weeks. But by the beginning of November, the spreads had fallen back to 65 basis points.

Because of the way the markets have responded to events during our sample period, we think it is important to look at high frequency data; with monthly or quarterly data one would run the risk of missing all of the interesting variation in the interest rate spreads. We therefore explore how weekly banking data respond to the paper-bill spread. These data come from the Federal Reserve's H.8 statistical release. Although the H.8 data contain much less detail than, for example, data from the Reports of Income and Condition (the "Call Report"), they do offer the highest frequency look at banking system that is available.[9] The weekly banking data are matched to interest rates on short-term government securities (3-months) and commercial paper rates. Our measure of market tightness, or the cost of market-provided liquidity, equals the spread between the 3-month commercial paper rate for highly rated borrowers (AA) and the 3-month T-Bill rate.

To test how spreads affect the banking system, we estimate a set of time series regressions where the dependent variable equals the growth rate of assets, the growth rate of loans (total loans and C&I loans), or the growth rate of liquid assets (cash plus securities). The explanatory variables are lags of the dependent variable and two interest rate variables: the level of the short-term interest rate (the three-month Treasury rate), and the spread between the commercial paper rate and this short-term interest rate.[10] Specifically, we match the interest rates observed on Friday to the growth rate in the banking variables over the subsequent week. Summary statistics for the banking-system growth rates and the interest rate variables appear in Table 1.

Results

The results show that the banking system grows faster in response to market tightness, and that this increased growth occurs across *both* lending and securities (Table 2, Panel A). The

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[9]We use the data from the 50 weekly reporting banks, not seasonally adjusted. These data reflect the activity of 50 large US banks as reported to the Federal Reserve. The Federal Reserve also reports statistics meant to reflect the activity of small banks, but these figures are imputed from the data on the weekly reporters using historical statistical relationships between large and small banks' balance sheets. Thus, they tend to be less reliable at high frequency.

[10]We have also tried including a term structure variable equal to the difference in the yields on five-year Treasury Notes and the three-month Treasury Bill. Adding this variable has little effect on the results.

coefficient on the paper-bill spread suggests, for example, that an increase of 26 basis points (the difference between the 75th and 25th percentiles) would be associated with an increase in weekly asset growth of 0.11 percent, which is large relative to the median weekly growth rate in bank assets of 0.10 percent. The coefficients also suggest that the increase in the growth rate of liquid assets is not only positive and statistically significant, but the increase is also *larger* than the increase in the rate of loan growth. For example, a 26 basis point rise in the spread is associated with an increase in the growth liquid assets of almost 0.24 percent, more than the average weekly growth in these assets.[11]

The coefficients on the lags of the dependent variable suggest little persistence in the effects of tightening spreads on lending. (These coefficients are not reported in the table.) For example, in the lending equations we estimate auto-regressive coefficients that are small and negative; for example, first lag has a coefficient of about -0.25, while the other lags have smaller coefficients. This suggests that an increase in market spreads only raises the growth rate of bank loans during the period of tight markets; once the market spreads decline, the growth rates quickly revert to their average levels. In the liquid asset growth equation, the lagged effects are also negative but much larger, with a first-order coefficient of about -0.7. This suggests that banks attempt to bring the *level* of liquid assets back to a target level very quickly following an unexpected increase or decrease due to change in market spreads. The large negative coefficient on the lagged dependent variable means that once the spread reverts to normal, liquid assets actually grow substantially more slowly than normal or even shrink thus allowing the banking system to return to the desired holdings of liquid assets rapidly.

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[11]We have tested for feedback effects from changes in the growth of bank assets to the commercial paper spread but found that these were not significant.

In Panel B of Table 2, we test how bank funding changes with the paper-bill spread. We regress the weekly growth in deposits, the growth in large time deposits (not fully insured), and other non-deposit liabilities, on the paper bill spread. These results suggest that the increase in asset growth is funded with additional deposits, particularly large deposits.

In Table 3, we regress the yield on large, three-month negotiable certificates of deposit minus the contemporaneous Treasury Bill rate on the same set of dependent variable lags and interest rate variables. In addition, we estimate a parallel regression using the three-month finance paper rate, again relative to the Bill rate. The results provide further evidence that bank funding availability increases as the commercial paper spreads widen. In particular, we find that banks' reliance on large time deposits increases significantly with the paper-bill spread and, at the same time, that the yield on large CDs *declines*. In contrast, funding costs for finance companies (such as GE Capital) do not decline.[12] Taken together, these two results suggest a shift in the willingness of large investors to hold bank deposits, presumably perceived to be safe, relative to commercial paper, during periods of weak investor confidence.

V. PRICING OF NEW LOAN COMMITMENTS

In this last section, we estimate how the pricing of *new* loan commitment responds to conditions in the commercial paper market. We have seen that when the paper-bill spread increases, funding availability increases so much that banks can actually increase their holding of liquid assets in the face of strong loan take-down demand. This result raises the possibility that the equilibrium price of new lines of credit may fall during periods of market tightness.

[12]We know of no high-frequency data (e.g. weekly) on finance company, or other financial institution, balance sheets that would allow us to observe how their assets and funding sources respond to changes in the paper-bill spread.

Methods and Data

To test this idea, we use the *Dealscan* database, compiled by the Loan Pricing Corporation (LPC). LPC is a private firm that collects up-to-date information on lending for its institutional clients. LPC also maintains a historical database, *Dealscan*, that contains information on the pricing and non-price terms of a large number of loans made over the past 10 years. The historical data in *Dealscan* come primarily from SEC filings, although LPC also receives data from large loan syndicators as well as from a staff of reporters. According to LPC, most loans made to large publicly traded companies (e.g. the Forbes 500) appear in *Dealscan.* There is very little information, however, on lending to small and middle-market firms (see Strahan, 1999), although this non-random selection of firms poses little trouble for our study because we will focus only on commercial paper borrowers.

Dealscan provides detailed information on bank loans to large corporations from 1988 to the present. Coverage in the database is sparse during the late 1980s, however, so we begin our sample in 1991. The *Dealscan* data have both price and non-price terms of loans at origination, along with information on borrower rating and borrower sales, but there is no information about pricing in the secondary market.[13] The pricing terms include both the "drawn all-in spread", which equals the annual cost to a borrower for drawn funds, inclusive of all fees. The drawn spread is defined as a markup over LIBOR. *Dealscan* also contains the "undrawn spread", equal to the annual fees that the borrower must pay its bank for funds committed under the line but not taken down.[14]

[13]For information on loan trading in the secondary market, see Carey and Bhasin (1999).

[14]LPC's use of the word "spread" when referring to fees on undrawn commitments puzzling because these fees are not markups over market interest rates.

In addition to the two pricing variables, *Dealscan* includes limited information on the borrower, allowing us to control for borrower risk with a set of Moody's senior-debt ratings indicators, and for borrower size by including the log of sales during the year prior to loan origination. We match the *Dealscan* data to three daily interest rate variables, the yield on the three-month Treasury Bill, a term structure variable equal to the difference between the yield on the five-year Treasury Note and the three-month Bill, and the paper-bill spread. The coefficient on the paper-bill spread allows us to test whether the price of new CP backup lines declines when the price of market-provided liquidity increases, as suggested by the strong funding availability to banks.

Beside the three interest rates and the variables controlling for borrower attributes, we also control for the non-price terms of the lines by including the log of the commitment amount, the log of maturity, and a secured indicator variable. Because these terms may be jointly determined with the prices, we estimate our models both with and without these variables. Finally, we introduce a log-linear trend variable into some specifications to rule out the possibility that common trends in interest rates can explain the results.[15]

We build our sample from the set of all commercial paper backup lines of credit on *Dealscan* originated between January 1, 1991 and the end of first quarter of 2002, for a total of 2,695 commitments. Of these, *Dealscan* contains information on the drawn spread for 2,155 commitments, and information on the undrawn fees for 1,882 commitments. Borrower sales is also missing for some of these loans, so our regression samples include between 1,520 and 1,720 observations. Also, because we sometimes have multiple observations on a single day, we report

[15]Note that we can not use standard time series techniques because we do not have lagged values of the variables; each loan is made only once, and the loans are not homogeneous.

standard errors that account for possible correlation in the error across loans made on the same day.

Table 4 reports the summary statistics for all of the variables in the models. The average drawn spread over LIBOR equals about 61 basis points (compared to a mean paper-bill spread of 30 basis points), and the average undrawn spread equals about 13 basis points. Most of the lines are secured (84 percent), and their average maturity equals 18 months. The backup lines tend to be large, with a mean commitment amount of $635 million, reflecting the large size of the typical commercial paper issuer (average sales size equals $8.6 billion). More that half of the borrowers have an S&P senior debt rating, although 43 percent of the borrowers do not have a rating.

Results

Tables 5 and 6 report the results from the loan pricing regressions. In Table 5, we omit the non-price term variables from the regressions (log of commitment amount, log of maturity and the secured indicator), while the specifications in Table 6 include these variables. Also, for each table we include two panels. Panel A reports the results with all of the available observations, including the 43 percent of borrowers without a debt rating and thus no way to control for borrower risk; in these regressions, we include an indicator equal to one for the un-rated borrowers. Panel B reports the results with only the set of borrowers with a Moody's rating. We also report two specifications in each panel, one that includes a log-linear time trend, and one without this variable. There are 16 specifications in all.

Before turning to the interest rate results, notice that the other variables enter the regressions with sensible coefficients. Larger borrowers, for example, pay lower drawn and undrawn spreads on their lines of credit. Also, the coefficients on the ratings indicators, which we do not report in the tables, suggest that higher-rated firms pay lower spreads than lower-rated firms. For example, a borrower rated Aa or better would pay, on average, about 8 basis points less for undrawn funds than a borrower rated below Baa and about 50 basis points less for funds drawn off of these lines.

The coefficients on the non-price terms suggest that larger loans come with lower spreads; longer term loans have higher undrawn spreads but lower drawn spreads; and, secured loans come with higher spreads than unsecured loans. These last three results, however, are especially hard to interpret because the price and non-price terms are jointly determined. So, for example, risky firms tend to pay high interest rates for funds *and* their loans tend to be secured, explaining the positive coefficient on the secured indicator even though the identical loan secured would be safer than if it were not secured.[16]

Looking now at the interest rate coefficients, in *all 16 specifications* in the two tables (eight for the drawn spread and eight for the undrawn spread), we find a statistically significant, negative relationship between the market price of liquidity (the paper-bill spread) and the price charged for liquidity insurance by banks. The result is robust across several dimensions. First, the coefficient on the paper-bill spread does not change appreciably when we add the non-price terms to the model; second, this coefficient does not change when we control for time trends; third, it does not change when we drop the un-rated firms. Moreover, the paper-bill spread is the *only* interest rate variable with a consistent impact on the pricing of these lines of credit. The other interest rate variables – the short-term interest rate and the term structure spread – do not have a consistent impact on either the drawn or the undrawn spread. (The coefficient on the term structure variable becomes indistinguishable from zero when we control for the time trend.)

[16] See Berger and Udell (1990) for evidence that secured borrowers are riskier than unsecured borrowers.

The coefficient on the paper-bill spread is not only statistically significant, but it is economically significant as well. For example, a one standard deviation increase in the paper-bill spread (20 basis points) is associated with an decrease in the drawn spread of about 3.2 basis point, or about 5 percent of the unconditional mean (60 basis points). A 20 basis point increase in the paper-bill spread comes with a decline of about 0.5 basis points in the undrawn spread, again about 5 percent of the unconditional mean (13 basis points).

While we have shown that the price of new commercial paper backup lines of credit declines with market spreads, even controlling for the non-price terms of the loans, Table 7 explores how these non-price terms themselves co-vary with the paper-bill spread. The results suggest no effect of spreads on either the commitment size or the likelihood that a loan commitment is secured. We do find, however, that the maturity of the backup lines declines with the paper-bill spread. According to the coefficients, a 20 basis point increase in the spread is associated with a decline in average maturity of about four percent (the dependent variables is in logs). So, banks offer new lines of credit more cheaply during periods of wide spreads, we argue, because of the inflow of funds. This last result on maturity suggests, however, that these new lines tend to be somewhat shorter lived than average, perhaps because banks anticipate that the strong funding availability is temporary.

VI. CONCLUSIONS

We have shown why banks are well suited to providing liquidity insurance to large borrowers. During periods when commercial paper spreads widen – periods when borrowing in the markets is expensive – banks are flush with funds. As evidence, we document that both loans and liquid assets grow faster at banks when the paper-bill spread widens and, at the same time, yields on large CDs fall. Borrowers are also more apt to take funds down from pre-existing lines of credit established during these tight times. Thus, because the funding is there when it is needed, banks can offer this liquidity insurance without having to carry a large bucket of liquid assets – assets that are costly to hold both because they earn low returns and because they exacerbate managerial agency problems. The funding inflows are not only useful in helping banks meet their obligations to customers when liquidity demands are high, but they are also large enough to allow banks to make new loan commitments at lower-than-average prices.

In our view, arguments about "bank specialness" must have something to do with a link or "synergy" between the funding and lending sides of the business. Otherwise, the specialness has to do with intermediation generally rather than banking. Our results find such a link. Because banks are viewed as a safe haven for funds, during periods of market uncertainty both the supply of bank funds and the demand for bank loans tend to move up together. This aspect of "specialness," however, could be the result of the market's perception that, ultimately, the government stands behind the banks. In this sense, banks may only be the liquidity provider of *second-to-last* resort.

References

Berger, Allen N. and Gregory F. Udell, 1992, "Some Evidence on the Empirical Significance of Credit Rationing," *Journal of Political Economy*.

Berger, Allen N. and Gregory F. Udell, 1990, "Collateral, Loan Quality and Bank Risk," *Journal of Monetary Economics*.

Boyd, John and Mark Gertler, 1994, "Are Banks Dead? Or, Are the Reports Greatly Exagerrated?" Federal Reserve Bank of Minneapolis, *Quarterly Review* (Summer 1994), 1-19.

Boot, Arnaud, Anjan Thakor and Gregory Udell, 1987, "Competition, Risk Neutrality and Loan Commitments," *Journal of Banking and Finance* 11, 449-471.

Calomiris, Charles W. and Charles M. Kahn, 1991, "The Role of Demandable Debt in Structuring Optimal Banking Arrangements, *American Economic Review* 81(3), 497-513.

Carey, Mark S., and Vijay Bhasin, 1999, "The Determinants of Corporate Loan Liquidity," Federal Reserve Bank of Chicago, *Proceedings of the 35th Conference on Bank Structure and Competition*.

Carey, Mark S., Mitch Post, and Steven Sharpe, 1998, "Does Corporate Lending by Banks and Finance Companies Differ? Evidence on Specialization in Private Debt Contracting, *Journal of Finance*, 53.

Chava, Sudheer, 2002, "Modeling Loan Commitments and Liquidity Crisis: Theory and Estimation," mimeo, November 19, 2002.

Diamond, Douglas and Ragurham G. Rajan, 2001, "Liquidity Risk, Liquidity Creation and Financial Fragility: A Theory of Banking," *Journal of Political Economy* 109(2), 287-327.

Fama, Eugene, 1985, "What's Different about Banks?" *Journal of Monetary Economics* (January).

Flannery, Mark, 1994, "Debt Maturity Structure and the Debtweight Cost of Leverage: Optimally Financing Banking Firms," *American Economic Review* (March), 320-331.

Froot, Kenneth A., and Jeremy C. Stein, 1998, "Risk Management, Capital Budgeting, and Capital Structure Policy for Financial Institutions: An Integrated Approach," *Journal of Financial Economics*, 47, 55-82.

Kanatas, George, 1987, "Commercial Paper, Bank Reserve Requirements and the Informational Role of Loan Commitments," *Journal of Banking and Finance* 11, 425-448.

Kashyap, Anil K, Raghuram G. Rajan and Jeremy C. Stein, 2002, "Banks as Liquidity Providers: An Explanation for the Co-existence of Lending and Deposit-Taking," *Journal of Finance* 57(1), 33-74.

Mishkin, Frederic and Philip E. Strahan, “What will Technology do to Financial Structure?” 1998, in *The Effect of Technology on the Financial Sector,* Brookings-Wharton Papers on Financial Services, edited by Robert Litan and Anthony Santomero, 249-87.

Mester, Loretta J., and Mitchell Berlin, 1999, “Deposits and Lending Relationships,” *Review of Financial Studies* 12, 579-608.

Mester, Loretta J., Leonard Nakamura and Micheline Renault, 2002, “Checking Accounts and Bank Monitoring,” Federal Reserve Bank of Philadelphia WP no. 01-3/R.

Morgan, Donald P., 1998, “The Credit Effects of Monetary Policy: Evidence Using Loan Commitments,” *Journal of Money, Credit and Banking*.

Myers, Stewart C. and Raghuram G. Rajan, 1998, “The Paradox of Liquidity,” *Quarterly Journal of Economics* 113, 733-71.

Saidenberg, Marc R. and Philip E. Strahan, 1999, “Are Banks Still Important for Financing Large Businesses?” 1999, Federal Reserve Bank of New York’s *Current Issues in Economics and Finance* 5(12), 1-6.

Shockley, Richard and Anjan Thakor, 1997, “Bank Loan Commitments: Data, Theory, Tests,” *Journal of Money, Credit and Banking* 29.

Strahan, Philip E., 1999, “Borrower Risk and the Price and Non-Price Terms of Bank Loans,” Federal Reserve Bank of New York, Staff Report no. 90.

Thakor, Anjan, and Gregory Udell, 1987, “An Economic Rationale for the Pricing Structure of Bank Loan Commitments,” *Journal of Banking and Finance* 11, 271-289.

Table 1
Summary Statistics for Weekly U.S. Banking-System Growth Rates

This table reports summary statistics for weekly growth rates in bank assets, deposits, loans and liquid assets (cash+securities). The sample is based on the aggregation of large U.S. banks that report weekly, from the Federal Reserve's H.8 statistical release, 1988 to 2002. Also reported is the paper-bill spread averaged over each quarter, defined as the 3-month commercial paper rate for highly rated borrowers minus the 3-month Treasury Bill rate, and the 3-month Treasury Bill rate.

	25th Percentile	Median	75th Percentile
Weekly Growth in Assets	-0.73%	0.10%	0.87%
Weekly Growth in Loans	-0.26%	0.04%	0.38%
Weekly Growth in C&I Loans	-0.35%	-0.02%	0.39%
Weekly Growth in Liquid Assets (securities+cash)	-1.75%	0.05%	2.03%
Weekly Growth in Deposits	-1.19%	-0.08%	1.37%
Weekly Change in Large Time Deposits/Assets	-0.72%	0.19%	0.67%
3-Month Treasury Bill Rate	4.11	5.18	5.94
3-Month Rate on Negotiable CDs - 3-month Treasury	0.18	0.31	0.51
3-Month Rate on Finance Paper - 3-month Treasury	0.08	0.19	0.37
Paper-Bill Spread	0.18	0.29	0.44

Table 2
Regressions of Weekly U.S. Banking System Growth Rates on Interest Rates, Paper-Bill Spread, and Dependent Variable Lags
Panel A: Asset Growth

This table contains 16 regressions, four per column. For each of the four dependent variables, we estimate the model with 1, 3, 5 and 7 lags of the dependent variable. Sample based on weekly data over the 1988 to 2002 period, from the Federal Reserve Board's H.8 statistical release. See Table 1 for summary statistics. Coefficients denoted '**' are statistically significantly different from zero at the 5% level; those denoted '*' are statistically significantly different from zero at the 10% level.

		Dependent Variables:			
Lags:		Asset Growth	Loan Growth	C&I Loan Growth	Liquid Asset Growth
One	Paper-Bill Spread	0.23 (0.21)	0.17 (0.10)	0.22** (0.10)	0.66 (0.48)
	Treasury Bill	-0.002 (0.03)	0.02 (0.013)	0.03* (0.01)	-0.09 (0.06)
	R^2	0.36	0.05	0.06	0.37
Three	Paper-Bill Spread	0.34* (0.20)	0.22** (0.11)	0.21** (0.10)	0.77* (0.46)
	Treasury Bill	-0.005 (0.03)	0.02 (0.014)	0.02 (0.013)	-0.11* (0.06)
	R^2	0.39	0.07	0.10	0.42
Five	Paper-Bill Spread	0.39* (0.21)	0.19* (0.11)	0.16 (0.10)	0.94** (0.46)
	Treasury Bill	-0.007 (0.03)	0.02 (0.014)	0.01 (0.01)	-0.14** (0.06)
	R^2	0.39	0.08	0.13	0.43
Seven	Paper-Bill Spread	0.42** (0.21)	0.22** (0.11)	0.14 (0.10)	0.93** (0.46)
	Treasury Bill	-0.008 (0.03)	0.02 (0.013)	0.01 (0.01)	-0.13** (0.06)
	R^2	0.39	0.08	0.14	0.43

Table 2
Regressions of Weekly U.S. Banking System Growth Rates on Interest Rates, Paper-Bill Spread, and Dependent Variable Lags
Panel B: Liability Growth

This table contains 12 regressions, four per column. For each of the four dependent variables, we estimate the model with 1, 3, 5 and 7 lags of the dependent variable. Sample based on weekly data over the 1988 to 2002 period, from the Federal Reserve Board's H.8 statistical release. See Table 1 for summary statistics. Coefficients denoted '**' are statistically significantly different from zero at the 5% level; those denoted '*' are statistically significantly different from zero at the 10% level.

		Dependent Variables		
Lags:		Growth in Deposits	Growth in Large Time Deposits	Growth in Non-Deposit Liabilities
One	Paper-Bill Spread	0.04 (0.32)	0.52** (0.26)	0.35 (0.38)
	Treasury Bill	0.02 (0.04)	0.01 (0.03)	-0.06 (0.05)
	R^2	0.22	0.01	0.18
Three	Paper-Bill Spread	0.41 (0.29)	0.61** (0.26)	0.16 (0.36)
	Treasury Bill	0.01 (0.04)	0.02 (0.03)	-0.05 (0.05)
	R^2	0.37	0.02	0.29
Five	Paper-Bill Spread	0.51* (0.29)	0.58** (0.26)	0.19 (0.36)
	Treasury Bill	0.01 (0.04)	0.01 (0.03)	-0.05 (0.05)
	R^2	0.38	0.05	0.30
Seven	Paper-Bill Spread	0.63** (0.29)	0.60** (0.26)	0.23 (0.35)
	Treasury Bill	0.01 (0.04)	0.01 (0.03)	-0.05 (0.05)
	R^2	0.40	0.05	0.34

Table 3
Regressions of Funding Costs to Banks and Finance Companies

This table contains 8 regressions, four per column. For each of the four dependent variables, we estimate the model with 1, 3, 5 and 7 lags of the dependent variable. Sample based on weekly data over the 1988 to 2002 period, from the Federal Reserve Board. See Table 1 for summary statistics. Coefficients denoted '**' are statistically significantly different from zero at the 5% level; those denoted '*' are statistically significantly different from zero at the 10% level.

		Dependent Variables	
Lags:		Yield on 3-Month Negotiable CDs Minus Treasury Rate	Yield on 3-Month Financial Paper Minus Treasury Rate
One	Paper-Bill Spread	-0.18**	-0.03
		(0.05)	(0.04)
	Treasury Bill	0.01**	0.01**
		(0.003)	(0.003)
	R^2	0.85	0.78
Three	Paper-Bill Spread	-0.16**	-0.02
		(0.05)	(0.04)
	Treasury Bill	0.01**	0.005*
		(0.003)	(0.003)
	R^2	0.85	0.79
Five	Paper-Bill Spread	-0.15**	-0.02
		(0.06)	(0.04)
	Treasury Bill	0.01**	0.005*
		(0.003)	(0.003)
	R^2	0.85	0.79
Seven	Paper-Bill Spread	-0.15**	-0.02
		(0.06)	(0.04)
	Treasury Bill	0.01**	0.005*
		(0.003)	(0.003)
	R^2	0.85	0.79

Table 4
Summary Statistics for New Commercial Paper Backup Lines of Credit, and Borrower Credit Rating and Size

This table reports means and standard deviations for price and non-price terms for all new commercial paper backup lines of credit that appear on the Loan Pricing Corporation's *Dealscan* database, along with borrower credit rating and sales size. The sample reflects loans made to borrowers between 1991 and 2002, although *Dealscan's* coverage of the market for lending to large firms grew substantially during the sample period.

	Mean	Standard Deviation
Drawn spread over LIBOR (basis points)	61	55
Undrawn Spread (basis points)	13	9
Three-Month Treasury (basis points)	466	126
Paper-Bill Spread (basis points)	30	20
Term Structure: 5-Year Note - 3-Month Bill (basis points)	98	95
Secured Indicator	0.84	-
Maturity (months)	18	15
Loan size (Millions $s)	635	1,032
Sales of borrower in year prior to loan (Millions $s)	8,604	14,754
Moody's Aa or better indicator	0.059	-
Moody's A1 indicator	0.056	-
Moody's A2 indicator	0.093	-
Moody's A3 indicator	0.086	-
Moody's Baa1 indicator	0.081	-
Moody's Baa2 indicator	0.070	-
Moody's Baa3 indicator	0.051	-
Moody's Ba indicator	0.045	-
Moody's B indicator	0.016	-
Un-rated indicator	0.430	

Table 5
Regressions of the Price of New Commercial Paper Lines of Credit
Panel A: All Commercial Paper Commitments

Each column in this table reports a regression of the drawn (undrawn) spread on new lines of credit issued to back commercial paper borrowing. Data on loan characteristics come from the Loan Price Corporation's *Dealscan* database. Standard errors take account of clustering in the residual (i.e. non independence) that may occur for loans originated on the same day. Coefficients denoted '**' are statistically significantly different from zero at the 5% level; those denoted '*' are statistically significantly different from zero at the 10% level.

	Drawn all-in Spread		Undrawn Spread	
Paper-Bill Spread	-0.17**	-0.16**	-0.028**	-0.034**
	(0.67)	(0.65)	(0.012)	(0.013)
3-Month Treasury	-0.01	0.01	0.007**	-0.003
	(0.02)	(0.02)	(0.003)	(0.004)
Term Structure Spread	-0.02	0.01	0.016**	-0.001
	(0.02)	(0.02)	(0.004)	(0.005)
Log of Sales	-6.52**	-6.49**	-1.16**	-1.17**
	(0.91)	(0.91)	(0.17)	(0.16)
Moody's Ratings Indicators	----------------*Included but not reported*----------------			
Log-linear Time Trend	-	38.63	-	-25.45**
		(23.66)		(5.43)
N	1,720	1,720	1,520	1,520
R^2	0.2102	0.2120	0.2095	0.2338

Table 5
Regressions of the Price of New Commercial Paper Lines of Credit
Panel B: Drop Unrated Borrowers

Each column in this table reports a regression of the drawn (undrawn) spread on new lines of credit issued to back commercial paper borrowing. Data on loan characteristics come from the Loan Price Corporation's *Dealscan* database. Standard errors take account of clustering in the residual (i.e. non independence) that may occur for loans originated on the same day. Coefficients denoted '**' are statistically significantly different from zero at the 5% level; those denoted '*' are statistically significantly different from zero at the 10% level.

	Drawn all-in Spread		Undrawn Spread	
Paper-Bill Spread	-0.16*	-0.14**	-0.026**	-0.032**
	(0.06)	(0.06)	(0.010)	(0.010)
3-Month Treasury	-0.03**	-0.01	0.004	-0.004
	(0.01)	(0.02)	(0.003)	(0.003)
Term Structure Spread	-0.036**	0.004	0.015**	0.001
	(0.017)	(0.022)	(0.004)	(0.004)
Log of Sales	-3.42**	-3.42**	-0.86**	-0.84**
	(0.72)	(0.73)	(0.15)	(0.14)
Moody's Ratings Indicators	----------------------*Included but not reported*----------------			
Log-linear Time Trend	-	63.86**	-	-21.91**
		(21.55)		(4.54)
N	1,294	1,294	1,181	1,181
R^2	0.2501	0.2571	0.2550	0.2814

Table 6
Regressions of the Price of New Commercial Paper Lines of Credit Including Non-Price Terms
Panel A: All Commercial Paper Commitments

Each column in this table reports a regression of the drawn (undrawn) spread on new lines of credit issued to back commercial paper borrowing. Data on loan characteristics come from the Loan Price Corporation's *Dealscan* database. Standard errors take account of clustering in the residual (i.e. non independence) that may occur for loans originated on the same day. Coefficients denoted '**' are statistically significantly different from zero at the 5% level; those denoted '*' are statistically significantly different from zero at the 10% level.

	Drawn all-in Spread		Undrawn Spread	
Secured Indicator	4.41**	4.85**	0.75*	0.59
	(2.09)	(2.08)	(0.42)	(0.41)
Log of Maturity	-3.07*	-1.88	1.53**	1.12**
	(1.58)	(1.59)	(0.41)	(0.35)
Log of Loan Size	-8.87**	-9.12**	-1.37**	-1.26**
	(1.30)	(1.31)	(0.23)	(0.22)
Paper-Bill Spread	-0.18**	-0.16**	-0.021*	-0.027**
	(0.06)	(0.06)	(0.012)	(0.012)
3-Month Treasury	-0.014	0.006	0.004	-0.004
	(0.015)	(0.018)	(0.003)	(0.004)
Term Structure Spread	-0.018	0.014	0.012**	-0.001
	(0.020)	(0.024)	(0.004)	(0.005)
Log of Sales	-3.87**	-3.78**	-0.77**	-0.80**
	(0.79)	(0.79)	(0.17)	(0.17)
Moody's Ratings Indicators	----------------------*Included but not reported*------------------			
Log-linear Time Trend	-	54.79**	-	-20.43**
		(23.42)		(5.39)
N	1,638	1,638	1,462	1,462
R^2	0.2511	0.2545	0.2352	0.2562

Table 6
Regressions of the Price of New Commercial Paper Lines of Credit Including Non-Price Terms
Panel B: Drop Unrated Borrowers

Each column in this table reports a regression of the drawn (undrawn) spread on new lines of credit issued to back commercial paper borrowing. Data on loan characteristics come from the Loan Price Corporation's *Dealscan* database. Standard errors take account of clustering in the residual (i.e. non independence) that may occur for loans originated on the same day. Coefficients denoted '**' are statistically significantly different from zero at the 5% level; those denoted '*' are statistically significantly different from zero at the 10% level.

	Drawn all-in Spread		Undrawn Spread	
Secured Indicator	4.28* (2.16)	4.94** (2.14)	0.60 (0.42)	0.43 (0.41)
Log of Maturity	-2.63* (1.42)	-1.36 (1.42)	1.29** (0.33)	0.97** (0.30)
Log of Loan Size	-3.85** (1.22)	-4.20** (1.23)	-0.94** (0.24)	-0.83** (0.23)
Paper-Bill Spread	-0.17** (0.06)	-0.15** (0.06)	-0.023** (0.010)	-0.029** (0.010)
3-Month Treasury	-0.032** (0.013)	-0.008 (0.016)	0.002 (0.003	-0.005 (0.003)
Term Structure Spread	-0.036* (0.018)	0.003 (0.022)	0.010** (0.004)	-0.001 (0.004)
Log of Sales	-2.12** (0.66)	-2.02** (0.66)	-0.55** (0.16)	-0.56** (0.16)
Moody's Ratings Indicators	----------------------*Included but not reported*------------------			
Log-linear Time Trend	-	66.39** (22.21)	-	-17.88** (4.47)
N	1,244	1,244	1,140	1,140
R^2	0.2686	0.2757	0.2851	0.3016

Table 7
Regressions of Non-Price Terms of New Commercial Paper Lines of Credit

Each column in this table reports a regression of the log of commitment amount, whether or not the loan is secured (in a probit) and the log of contractual maturity on new lines of credit issued to back commercial paper borrowing. Data on loan characteristics comes from the Loan Price Corporation's *Dealscan* database. Standard errors take account of clustering in the residual (i.e. non independence) that may occur for loans originated on the same day. Coefficients denoted '**' are statistically significantly different from zero at the 5% level; those denoted '*' are statistically significantly different from zero at the 10% level.

Explanatory Variables	Log of Commitment Amount		Fraction of loans Secured		Log of Contractual Maturity	
Paper-Bill Spread	0.001 (0.001)	0.001 (0.001)	-0.0003 (0.0006)	-0.0005 (0.0005)	-0.002** (0.0006)	-0.002** (0.0006)
3-Month Treasury	-0.0009** (0.0003)	-0.0002 (0.0003)	0.0002 (0.0002)	-0.0001 (0.0002)	0.0007** (0.0002)	-0.0001** (0.0002)
Term Spread	-0.0014** (0.0004)	-0.0006 (0.0004)	0.0004** (0.0001)	0.0001** (0.0002)	0.0017** (0.0002)	0.0003 (0.0002)
Log of Sales	0.272** (0.023)	0.272** (0.022)	-0.013** (0.006)	-0.013** (0.006)	0.024** (0.0085)	0.022** (0.0082)
Ratings Indicators	--------------------------*Included but not Reported*-----------------------					
Log-linear Time Trend	-	1.834** (0.432)	-	-0.637** (0.179)	-	-2.003** (0.235)
N	2,035	2,035	2,036	2,036	1,875	1,875
R^2	0.2531	0.2613	0.0476	0.0553	0.0641	0.1034

Appendix

A.1 The Basic equation.

Using $E[L]$=0 in the first line and the normality of L in the third and fourth lines yields

$$\begin{aligned} Cov(\alpha r_D, L) &= E[\alpha(L) r_D L] \\ &= Cov(r_D, \alpha(L)L) + E[r_D]E[\alpha(L)L] \\ &= \frac{\sigma_{r_D L}}{\sigma_L^2} E[\alpha(L)L^2] + E[r_D]E[\alpha(L)L] \end{aligned}$$

The second line uses the fact that for the bivariate normal random variables r_D, L, we have

$$Cov(r_D, f(L)) = \int f(L) E[r_D|L]\phi(L)dL - E[r_D]E[f(L)] = Cov(r_D, L)\int f(L)(\frac{L}{\sigma_L^2})\phi(L)dL$$

where $\phi(L) = \exp(-L^2/2)$ is the standard normal density.

When α is twice differentiable, the normality of L and Stein's lemma imply

$$\begin{aligned} Cov(\alpha r_D, L) &= Cov(r_D, \alpha(L)L) + E[r_D]E[\alpha(L)L] \\ &= E[(\alpha(L)L)']\sigma_{r_D L} + E[r_D]E[\alpha(L)L] \\ &= (E[\alpha'(L)L] + E[\alpha(L)])\sigma_{r_D L} + E[r_D]E[\alpha(L)L] \\ &= (E[\alpha''(L)]\sigma_L^2 + E[\alpha(L)])\sigma_{r_D L} + E[r_D]E[\alpha(L)L] \end{aligned}$$

A.2 The linear case B)

Using the partial expectations of a function of the normally distributed L, we have

$$\frac{dE[r_{LC}]}{d\sigma_{r_D L}} = -\frac{\gamma}{\sigma_L^{\,2}}E[\alpha(L)L^2]$$

$$= -\frac{\gamma}{\sigma_L^{\,2}}\ \Big(\ E[\chi_{[-\infty,L_{hi}]}L^2] + \frac{L_{hi}}{L_{hi}-L_{lo}}E[\chi_{[L_{lo},L_{hi}]}L^2] - \frac{1}{L_{hi}-L_{lo}}\ E[\chi_{[L_{lo},L_{hi}]}L^3]\ \Big)$$

$$= -\gamma\ \Big(\ \Phi(\frac{L_{lo}}{\sigma_L})-\frac{L_{lo}}{\sigma_L}\phi(\frac{L_{lo}}{\sigma_L}) + \frac{L_{hi}}{L_{hi}-L_{lo}}[\Phi(\frac{L_{hi}}{\sigma_L})-\frac{L_{hi}}{\sigma_L}\phi(\frac{L_{hi}}{\sigma_L})-\Phi(\frac{L_{lo}}{\sigma_L})+\frac{L_{lo}}{\sigma_L}\phi(\frac{L_{lo}}{\sigma_L})] -$$

$$-\ \frac{1}{L_{hi}-L_{lo}}\ [(\frac{L_{lo}^{\,2}}{\sigma_L}+2\sigma_L)\phi(\frac{L_{lo}}{\sigma_L})-(\frac{L_{hi}^{\,2}}{\sigma_L}+2\sigma_L)\phi(\frac{L_{hi}}{\sigma_L})]\ \Big)$$

$$= -\frac{\gamma\sigma_L}{L_{hi}-L_{lo}}\ [\ \frac{L_{hi}}{\sigma_L}\Phi(\frac{L_{hi}}{\sigma_L}) - \frac{L_{lo}}{\sigma_L}\Phi(\frac{L_{lo}}{\sigma_L}) + 2(\phi(\frac{L_{hi}}{\sigma_L}) - \phi(\frac{L_{lo}}{\sigma_L}))\ ]$$

where Φ and ϕ denote the standard normal cumulative distribution and density respectively. The relevant partial expectation formulas are

$$E[\chi_{[-\infty,L^*]}L^2] = \sigma^2\int_{-\infty}^{\frac{L^*}{\sigma_L}}L^2\phi(L)dL = \sigma^2[\Phi(\frac{L^*}{\sigma_L}) - (\frac{L^*}{\sigma_L})\phi(\frac{L^*}{\sigma_L})]$$

$$E[\chi_{[-\infty,L^*]}L^3] = \sigma^3\int_{-\infty}^{\frac{L^*}{\sigma_L}}L^3\phi(L)dL = -\ \sigma^3[(\frac{L^*}{\sigma_L})^2+2]\phi(\frac{L^*}{\sigma_L})$$

A.3 The step function

At the limit $L_{low} \to L_h$ α becomes the step function $\chi_{[-\infty, Lhi]}$ and in that case, we have

$$\frac{dE[r_{LC}]}{d\sigma_{r_D L}} = -\gamma\ [\ \Phi(\frac{L_{hi}}{\sigma_L}) - \frac{L_{hi}}{\sigma_L}\phi(\frac{L_{hi}}{\sigma_L})\ ]$$

We used

$$\lim_{L_{low} \to L_{hi}} \frac{\frac{L_{hi}}{\sigma_L}\Phi(\frac{L_{hi}}{\sigma_L}) - \frac{L_{lo}}{\sigma_L}\Phi(\frac{L_{lo}}{\sigma_L})}{L_{hi} - L_{lo}} = [\frac{L}{\sigma_L}\Phi(\frac{L}{\sigma_L})]'_{|L=L_{hi}} = \frac{1}{\sigma_L}\ [\ \Phi(\frac{L_{hi}}{\sigma_L}) + \frac{L_{hi}}{\sigma_L}\phi(\frac{L_{hi}}{\sigma_L})\ ]$$

and

$$\lim_{L_{low} \to L_{hi}} \frac{\phi(\frac{L_{hi}}{\sigma_L}) - \phi(\frac{L_{lo}}{\sigma_L})}{L_{hi} - L_{lo}} = \phi'(\frac{L}{\sigma_L})_{|L=L_{hi}} = -\frac{L_{hi}}{\sigma_L^2}\ \phi(\frac{L_{hi}}{\sigma_L})$$